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NOSC

NOSC TR 568

NOSC TR 568

Technical Report 568
(NEMP-I-80-H-0001)

MEASUREMENTS OF OCEAN SPECTRAL IRRADIANCE FOR CORRELATION WITH SATELLITE REMOTE SENSING

R.F. Howarth

1 May 1980

Final Report for Period 6 February - 1 May 1980

Approved for public release; distribution unlimited

NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152

NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92152

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ADMINISTRATIVE INFORMATION

The work was performed by a representative of the NOSC Communications Research and Technology Division under joint sponsorship of the Naval Electronic Systems Command, the Office of Naval Research, the Defense Advanced Research Projects Agency, and the US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Monitoring Program (Dr. John B. Pearce, Manager). The period covered by this report is 6 February–1 April 1980, and is based on the NIMBUS VII Coastal Zone Color Scanner (CZCS) experiment conducted aboard the National Oceanic and Atmospheric Administration Research Vessel ALBATROSS IV during February 1980. The designation NEMP-I-80-H-0001, which appears on the cover, is the Department of Commerce identification of this report. The field procedures, as well as data handling and computer processing techniques, are presented in detail in accordance with a Bureau of Fisheries request, so that they might be used in the development of approaches for future work.

Released by
Dr. M. S. Kvigne, Head
Communications Research and
Technology Division

Under authority of
H. D. Smith, Head
Communications Systems and
Technology Department

ACKNOWLEDGMENTS

The author wishes to express appreciation to colleague M. E. Hyde for his assistance in data reduction and for his helpful discussion regarding this work. Appreciation is also extended to T. E. Keenan for his suggestions and managerial support, which contributed significantly toward this publication.

(14) NOSC/TR-568

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
NOSC Technical Report 568 (TR 568)
(NEMP-1-80-H-0011)

2. GOVT ACCESSION NO.
AD-A093312

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
(6) MEASUREMENTS OF OCEAN SPECTRAL IRRADIANCE FOR CORRELATION WITH SATELLITE REMOTE SENSING.

5. TYPE OF REPORT & PERIOD COVERED
(9) Final rept. 6 February - 1 April 1980

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
(10) R.F. Howarth

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Naval Ocean Systems Center
San Diego, CA 92152

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
US Department of Commerce
National Oceanographic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Highlands, NJ 07732

(12) 103

12. REPORT DATE
(11) 1 May 1980

13. NUMBER OF PAGES
104

15. SECURITY CLASS. (of this report)

UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Oceans
Satellites
Underwater visibility
Spectral irradiance
Remote sensing
Radiometry
Expendable bathythermographs

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Underwater ocean truth data were collected in conjunction with the NIMBUS VII Coastal Zone Color Scanner (CZCS) experiment. The data were provided to permit a correlation of remote radiometric measurements with the biological constituency and optical properties of the seawater investigated. Preliminary examination of expendable bathythermography data indicates that a correlation between irradiance data and water temperature may exist where the thermocline structure is significant.

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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PROBLEM

Collect underwater ocean truth data in conjunction with the NIMBUS VII Coastal Zone Color Scanner (CZCS) experiment. Provide collected data for correlation of remote radiometric measurements with the biological constituency and optical properties of the seawater investigated.

RESULTS

Downwelling and upwelling spectral irradiance measurements were made at five stations in the Atlantic Ocean and the Gulf of Mexico for correlation with concurrent satellite measurements. Preliminary examination of expendable bathythermograph data suggests that a correlation between irradiance data and water temperature may exist where thermocline structure is significant.

RECOMMENDATIONS

1. Comparison and possible correlation among spectral irradiance, spectral K, and chlorophyll and/or suspended matter should be attempted.

2. Possible correlation between irradiance data and water temperature should be examined.

3. Use of a ship's electronics laboratory as a control site for radiometric work is recommended, since such an arrangement proved effective during the NOAA CZCS cruise.

4. Since it was determined that the euphotic depth ≈ 4 X the Secchi disk depth, it is recommended that this be employed as a first approximation of euphotic depth.

5. Significant modifications should be made to the underwater irradiance meter to improve the quality of the measurements, increase depth resolution, and reduce time on station.

CONTENTS

ILLUSTRATIONS

TABLES

1.0 INTRODUCTION

1.1 BACKGROUND

The Naval Ocean Systems Center (NOSC) has been engaged for some 10 years in various programs and efforts to investigate and effect optical communication between airborne/satellite and underwater platforms. Such involvement necessarily requires analysis and mathematical modeling of the propagation path or "link" consisting of the atmosphere, the air-sea interface, and the sea itself[1]. Because the properties of the seawater portion dominate and largely constitute the salient characteristics of the link, significant analysis, study, and field measurement of the seawater path have been performed by NOSC personnel.[2,3] Indeed, this measurement activity and need for seawater-related information is a continuing concern in contemporary programs at NOSC.

A portion of the Strategic Blue/Green Optical Communications Program, under the sponsorship of the Naval Electronic Systems Command, the Office of Naval Research, and the Defense Advanced Research Projects Agency is concerned with investigating the possibility of correlation between remote radiometric measurements of the sea surface made from satellites and the optical parameters of the underlying sea. As technical advisor for this program, and in view of our background, it was fitting that NOSC should favorably respond to an inquiry from US Department of Commerce, National Bureau of Fisheries, regarding the possibility of cooperative support in obtaining detailed underwater data in conjunction with NIMBUS VII satellite measurements.

1.2 PURPOSE

The purpose of the NOSC participation in the oceanic cruise of the Research Vessel ALBATROSS IV was to collect underwater ocean data in conjunction with the NIMBUS VII Coastal Zone Color Scanner (CZCS) experiment. Underwater spectral irradiance measurements were to be made in six narrow spectral bands to euphotic depth at a time coincident with satellite flyover. Water chlorophyll and suspended matter samples would be taken by marine hydrocasts performed by Bureau of Fisheries personnel simultaneous with the NOSC-conducted measurement. The data collected would be compared later to provide a correlation of remote radiometric satellite measurements with the biological constituency and optical properties of the seawater investigated.

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[1] NOSC TR 387, Naval Blue/Green Single-Pulse Downlink Propagation Model, by Technical Advisor to the Blue/Green Optical Communication Program Joint Coordinating Committee, 1 January 1979.

[2] NELC TD 489, Submarine/Aircraft Optical Communications System (SAOCS), vol III, Feasibility System Description, by D. O. Milstead et al, 28 October 1976.

[3] NELC TD 490, OPSATCOM Field Measurements, vol II, by R. D. Anderson et al, 1 June 1976.

2.0 CRUISE DESCRIPTION

2.1 SCHEDULE

NOAA Cruise 80-01 began as the RV ALBATROSS IV departed from Woods Hole, MA, in midafternoon on 4 February 1980; the weather was clear and cold (21°F). As the vessel proceeded southward, the sky was generally overcast, the sea was moderately rough to rough at times, and the air temperature gradually increased.

The first radiometric measurements were taken on 6 February at station 15 under overcast sky. The deployment procedure agreed upon was implemented successfully despite light snow flurries; some difficulty was encountered in stowing the underwater unit after taking the measurements. After some discussion, it was decided to move the NOSC radiometer control site from the main deck wet lab to the next upper deck in the electronics lab area. This new location proved highly satisfactory and was used for the remainder of the cruise.

Malfunctioning of the NOSC radiometer was detected late on the afternoon of 6 February after the move. After performing checks for loose components, moisture, leakage, broken wires, etc, console readout indications were still unsatisfactory and attempts were made on 7 February to contact the instrument's manufacturer by radiophone patch. After appreciable effort and several poor contacts, further efforts were postponed until 8 February.

During successful radiophone patch communication on 8 February, arrangements for shipment of suspected failed parts were made. These would be awaiting scheduled arrival of RV ALBATROSS IV in Miami, FL, on 12 February 1980. Further checks suggested during the radio communication reinforced the choice of replacement parts to be shipped and also negated any need for further talks with the manufacturer.

Deck cell measurements of total sky illuminance were made from about 0800 to 1600 hours from 9 February through 17 February inclusive; sun/sky ratio was measured on the few days when the sun was visible. Underwater spectral irradiance measurements were reinitiated on 13 February after successful installation and checkout of electronic components at Miami on 12 February. Satisfactory data collection was performed on 13, 14, 15, 16, and 17 February during satellite flyover, although sky conditions featured broken clouds or overcast.

Hydrocasts for chlorophyll content and suspended matter were made, and expendable bathythermographs (XBTs) were made during eight of the 12 possible candidate flyovers to form an incomplete measurement complement. It was anticipated that these data could help to establish correlation between non-optical water characteristics and the remote satellite measurements. Later correlations between underwater spectral irradiance measurements, hydrocast-XBT data, and data from the satellite might possibly be strengthened by the incomplete measurement complement.

2.2 SATELLITE FLYOVER TIME

A calculation was made prior to 0800 hours each morning to determine the flyover time and longitudinal displacement of NIMBUS VII for that day. An estimate of ship's position for near midday was obtained from Chief Scientist R. Marak or from Ship's Commander M. Fleming. This information, plus orbital tables and a temporal-positional correction curve for NIMBUS VII, were used to effect the calculation. After determining flyover time, the author would so inform the Chief Scientist and also post the information on the chalk board in the Scientists' Study, where numerous daily briefings were held.

About 45 minutes prior to flyover, the ship was stopped, XBT and hydrocast measurements were made and then the NOSC radiometer was deployed. The timing was such that satellite flyover occurred about midway through the spectral irradiance measurement set. Figure 2-1 shows the ship's positions for the candidate satellite flyovers.

2.3 SATELLITE SUMMARY

A summary of satellite-related conditions and of the measurements taken during the cruise is given in table 2.1.

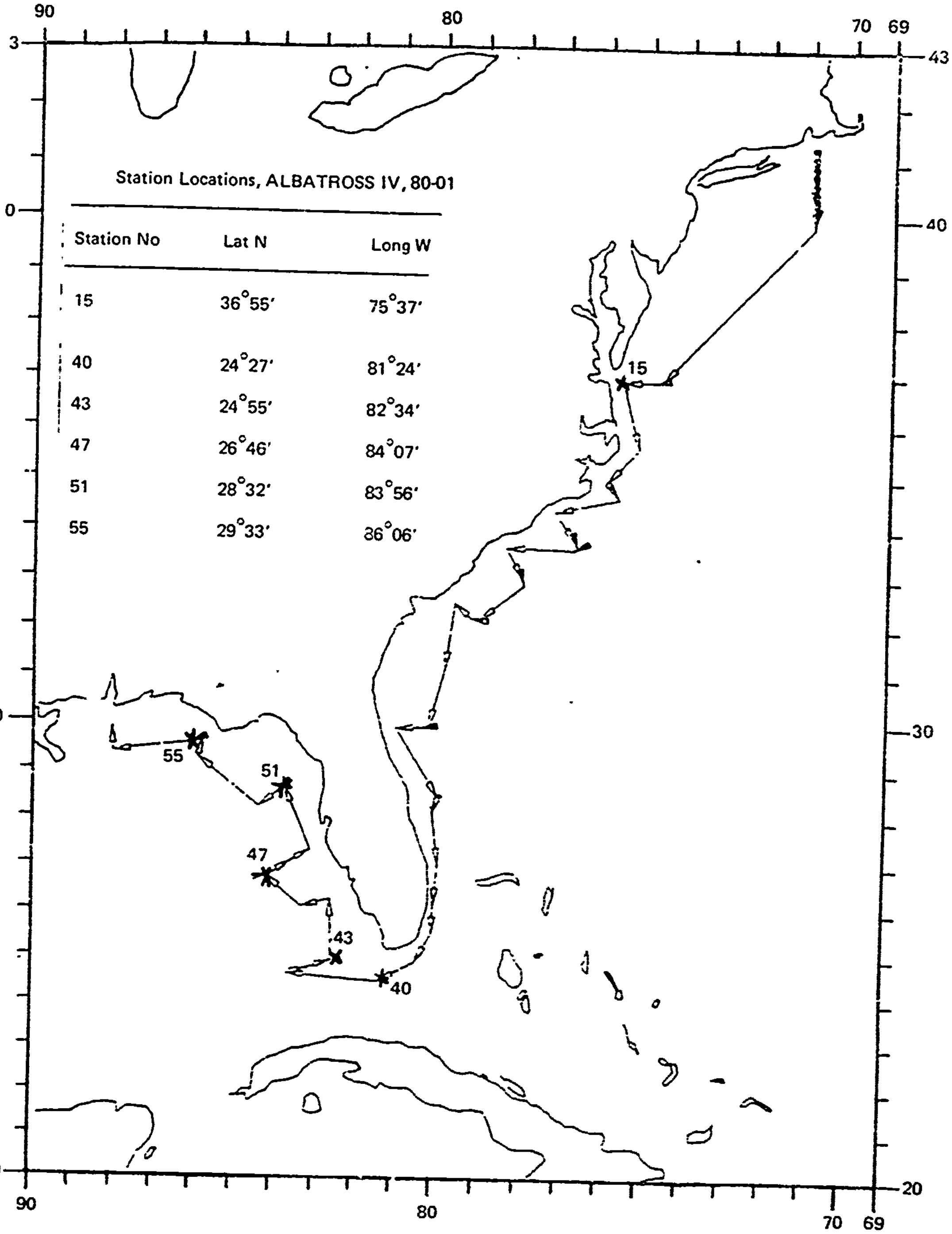
3.0 MEASUREMENT SYSTEM

3.1 SPECTRAL IRRADIANCE METER

The underwater radiometer used on this cruise was built to NOSC specifications by Research Support Instruments, Inc, of Timonium, MD, and their electronics subcontractor, Spa Com Electronics of Camarillo, CA. The instrument, Model 31-187, is a six-channel oceanographic optical instrument system consisting of sensor, tankage, cabling, and surface control unit.

The sensor assembly consists of cosine collectors to collect the downwelling and upwelling radiation, a rotating mirror to direct the radiation to the detector, and a detector assembly. The various wavelengths are selected by indexing filters in a wheel into the beam. Six positions are available, nominally 440 nm, 488 nm, 500 nm, 520 nm, 550 nm, and 670 nm. The detector is a minature photomultiplier tube packaged in a pulse amplifier-high voltage supply package. These components are housed in a stainless steel tank designed for use at depths to 150 m.

The surface control unit controls and monitors all functions of the sensor. The detector system pulse output is fed to this unit, where the microprocessor system averages the data to reduce surface effects, subtracts dark count information, and provides autoranging. The system has a total dynamic range of 10^6. The data are displayed on an LCD monitor, and are also available at connector outputs as raw pulses and analog information. Calibration is discussed in appendix A.



Station Locations, ALBATROSS IV, 80-01

Station No	Lat N	Long W
15	36°55'	75°37'
40	24°27'	81°24'
43	24°55'	82°34'
47	26°46'	84°07'
51	28°32'	83°56'
55	29°33'	86°06'

Figure 2-1. Cruise track for ALBATROSS IV, 80-01.

Date, Feb 80	Station No	Flyover Time[1]	Longitude Displacement[2]	% Cloud Cover[3,5]	Zenith Photo[4]	Sky Luminance[5]	Hydrocast
6	15*	1040	+11.6°	100	0	X	0
7	--[a]	1058	- 7.3°[a]	100	0	0	0
8	23	1117	- 4.1°	0	0	0	X
9	27	1136	- 1.6°	100	0	X	X
10	30	1153	+ 1.2°	100	0	X	0
11	33	1212	+ 5.0°	100	0	X	0
12	37	1046	-16.0°	$S/S_1=5.5$	0	X	X
13	40*	1104	+11.4°	<100	0	X	X
14	43*	1123	-10.0°	<100	0	X	X
15	47*	1143	- 6.4°	100	0	X	X
16	51*	1202	+ 0.08°	≈50	X	X	X
17	55*	1221	+ 1.79°	≈75	X	X	X

1 Eastern Standard Time

2 Longitudinal difference between ship's position and meridional plane of satellite orbit. Negative displacement indicates ship was west of orbital plane; positive means ship was east of orbital plan.

3 Estimated at flyover time.

4 Collection of this extra bit of information was initiated at station 51.

5 Sky luminance measured with photopic deck cell; S/S_1 indicates sun/sky ratio where applicable.

* Underwater spectral irradiance measurements taken.

a Estimated from XBT log; between stations 17 and 18.

X Measurement made or action taken.

0 No measurement or action.

Table 2-1. Satellite flyover conditions.

The sensor can be commanded to operate in two modes, either continuously running or pausing. In the continuous run mode, each filter is indexed into the light path and held for about 15 seconds; then the next filter is moved

into position. Total cycle time is about 2 minutes, and the sensor will operate in this fashion continuously. In the pause mode, a filter must be commanded into position. Front panel readout will give the filter position.

The underwater unit (UWU) was mounted in a 0.76-m-diameter stainless steel hoop and bridle assembly for deployment. A lead weight of 100 pounds was suspended from the hoop to stabilize the unit and to minimize wire angle. The effectiveness of this arrangement was quite satisfactory, as observed by the operator viewing the LCD readout of UWU pitch and roll which, for the most part, were nearly always less than ± 3°. Instrument depth was also read from the LCD and then recorded for each measurement sequence. Figure 3-1 is a block diagram of the equipment complement. Appendix B lists the spectral filter characteristics and appendix F shows the deployment hoop.

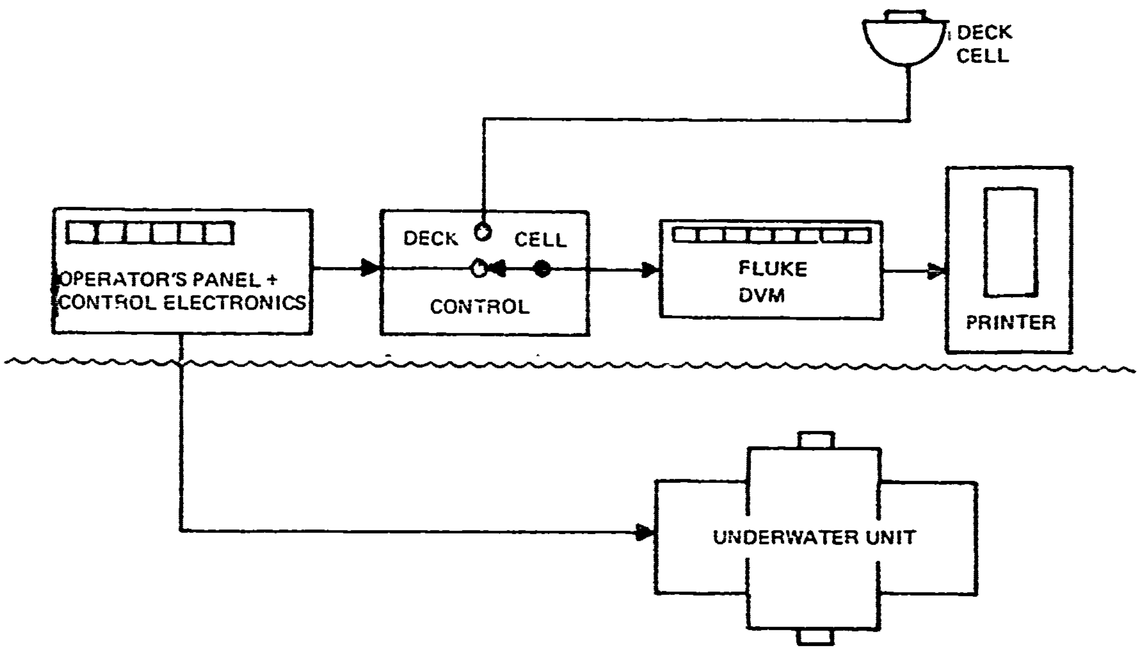


Figure 3-1. System block diagram.

3.2 DECK CELL

This unit consists of a Weston photovoltaic cell and diffuse cosine collector mounted in a two-axis gimbal frame. The cell is fitted with a Wratten 102 spectral filter which results in photopic response and hence measures illuminance (lumens foot^{-2}). The model C-1 deck cell and the model S-1 control box-readout were manufactured by Bendix Environmental Science Division of Baltimore, MD.

The S-1 control box was modified at NOSC to provide a millivolt analog signal to the data recorder upon operator demand. A circuit diagram and a calibration conversion are given in appendix F.

The deck cell assembly was daily mounted topside on the outboard railing of the afterdeck of ALBATROSS IV. Some occlusion of a portion of the sky was caused by one of the ship's air exhaust stacks, but this was considered relatively insignificant in that the occluded solid angle was small, vessel orientation relative to the sun was relatively fixed during the measurement period, and the frequency of shadow presence was small due to the generally extant overcast conditions.

3.3 RECORDING PRINTER

Millivolt analog signals from the irradiance radiometer and from the deck cell were applied by operator-actuated switch to a Fluke model 8800A digital multimeter coupled to a Fluke model 2010A paper printer, which generated the permanent printed tape. Output resolution was 10^{-6}, accuracy was 0.01%. The data period was 10 seconds for each record (ie, the period over which the 10-ms accumulate time, 16-bit data from the UWU are averaged). Figure 4-1 and appendix C show typical data records.

4.0 MEASUREMENT PROCESS

These sections describe the measurements related to obtaining the desired underwater data germane to the NIMBUS VII CZCS experiment.

4.1 SCHEDULE

The schedule outlined in table 4-1 was defined essentially as shown prior to the first flyover. A few changes were made as the cruise proceeded. Item 6 was added near the end of the cruise. Ordinarily, all the measurements under 5 were completed just prior to placing the NOSC radiometer into the water to avoid the possibility of cable intertwine; ie, only one cable in the water at one time was the rule followed.

4.2 PROCEDURE

The customary preparations for measurement and the implementation of the radiometric measurements are listed in table 4-2.

At each data depth, the radiometer operator performs the required actions to generate a printed data tape similar to that shown in figure 4-1. During the measurement period, the continuous sequence capability of the spectral filter changer in the underwater unit is utilized and the operator must press the "print" button on the Fluke model 2010A printer at the appropriate times. Hand notes indicating depth, time of day, downwelling (Dn/W) or upwelling, (Up/W) also must be entered on the paper tape by the radiometer operator. Depth determination is done by the radiometer operator, who reads the LCD depth indication on the radiometer control panel and relays this information by "walkie-talkie" radio to the deck technician and to the winch operator.

Bkg
1222
UP/W
48 m

,000303
,000304
,000204

,004415
,005530

,000303
,000302

,000302
,000302

,000302
,000302

,000302
,000302

,000303
,000303

,000303
,000303

,004710
,004571

1219
DN/W
48m

,006036
,006464

,000307
,000302

,010674
,010674

,019226
,019226

,024104
,024104

,028371
,028371

,005184
,005183

,010495
,010593

Figure 4-1. Data tape record.

Item	Time, hours	Action	Bridge	Chief Scientist	Radiometer Operator	Deck Technician	Winch Operator	Deck Assistant
1	0800	Request expected position @1100	X	X	X	--	--	--
2	0830	Compute flyover time by using expected position, T_o; post	--	--	X	--	--	--
3	T_o-1	Connect deck cell, turn on system, warm up, check operation	--	--	X	X	--	--
4	T_o-0.5	Take & log latitude, longitude, & wind velocity (corrected)	X	--	X	--	--	--
		Make depth sounding	X	--	--	--	--	--
5	T_o-0.4	Implement data run	X	X	X	X	--	--
		Take Secchi Disk	--	--	--	X	--	--
		Take XBT	--	--	--	X	--	--
		Take bucket temperature	--	--	--	X	--	--
		Take chlorophyll, hydrocast	--	--	--	X	X	--
		Make radiometric measurements	--	--	X	X	X	--
6	T_o	Take zenith sky photo	--	--	--	--	--	X
		Take sun/sky readings	--	--	--	--	--	X
7	T_o+1	Complete operator log sheet	--	--	X	--	--	--

Table 4-1. NOAACZCS schedule for radiometric experiment.

Preparation

- o Deck cell--Set out and connect
- o UW cable--Place on deck for deployment
- o Weight--Attach to lower portion of bridle
- o Attachment--Tape lowest 5 to 6 m of UW cable to winch wire
- o Walkie-talkies--Operator to deck chief.

Measurement

- o Air Reference--(With unit dry) hold loop 1 to 1 1/2 m above water; (With stabilizing weight in water) data set, Dn/W only.
- o Subsurface reference--Hold hoop 1/2 to 1 m below surface; data set, Dn/W and Up/W.
- o 1% descent--Lower unit to estimated euphotic depth as determined by Secchi measurement. Check for 1% reading and adjust depth as required. Data set, Dn/W and Up/W.
- o Raise to 1/2 of 1% depth--Take data set, Dn/W and Up/W.
- o Increment up--Raise in 2 or 3-m increments. Data sets.
- o Subsurface reference (check)--Just prior to removal.

Table 4-2. NOAACZCS radiometric measurements procedure.

5.0 DATA REDUCTION

5.1 CORRECTION PROCEDURE

The correction procedure used and the justification for it are described in this section.

Definition of symbols:

Let:

R_{si} = raw signal as recorded on printer

R_D = dark reading as recorded on printer

R_i = net signal = $R_{si} - R_D$

E_{00} = deck cell signal at initiation of R_{si} measurements as recorded on printer

E_{0z} = deck cell signal when underwater sensor is at depth Z meters, as recorded on printer

$E_{01} = E_{oz}$ taken at start of each filter sequence

$E_{02} = E_{oz}$ taken at end of each filter sequence

$\Delta E_0 = E_{02} - E_{01}$

$\Sigma_{E0} = E_{01} + E_{02}$

i = filter index, $1 \leq i \leq 6$.

Reference to figure 5-1 should facilitate ready comprehension of the data correction procedure.

For any filter $1 \leq i \leq 6$, the corrected signal R' (ignoring subscripts) can be expressed as:

$$R' = [R + R\ (ISF)]\ (CF) \tag{5.1}$$

where

ISF = intrasequence correction factor

CF = ambient correction factor.

ISF is needed because the surface ambient irradiance, E_{0z}, is measured and recorded on the printer just prior to and just after each six-filter measurement set (sequence); these measurements are E_{01} and E_{02}, respectively. The assumption is made that any change in E_{0z}, (eg, $E_{02} - E_{01} = \Delta E_0$) is linear over the sequencing interval and that linear correction is applicable.

Therefore, ISF can be expressed as

$$ISF = \frac{\text{filter number}}{7} \frac{E_{02} - E_{01}}{E_{01}} \tag{5.2}$$

or

$$ISF = 0.143\ (\text{filter number})\ \frac{\Delta E_0}{E_{01}}\ . \tag{5.3}$$

The factor CF arises from the same source, the change in surface ambient, but for a much longer temporal period than the filter sequence interval. Change in sun elevation angle and variations in the atmospheric path (haze,

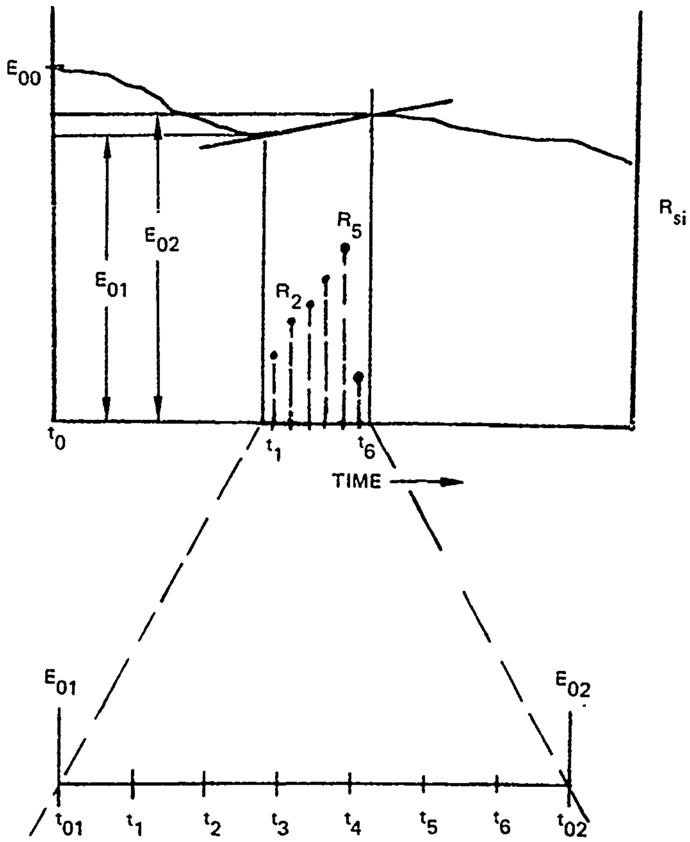


Figure 5-1. Data correction scheme.

light fog) are the types of phenomenon that require the correction approximated by CF. The ambient correction factor can be expressed as

$$CF = \frac{E_{00}}{E_{01}} \cdot \tag{5.4}$$

By utilizing the above, the expression to obtain the corrected signal R' can be written

$$R' = R\ (1 + ISF)\ (CF)$$

or

$$R' = R \left[1 + 0.143\ (\text{filter number})\ \frac{\Delta E_0}{E_{01}} \right] \times \frac{E_{00}}{E_{01}} \cdot \tag{5.5}$$

For spectral filters 1 through 6, table 5-1 provides the corrected signal (relative irradiance).

Filter No	
1	$R'_1 = R_1\ (1 + 0.143\ \Delta E_0/E_{01}) \times E_{00}/E_{01}$
2	$R'_2 = R_2\ (1 + 0.286\ \Delta E_0/E_{01}) \times E_{00}/E_{01}$
i	$R'_i = R_i\ (1 + 0.143i\ \Delta E_0/E_{01}) \times E_{00}/E_{01}$

Table 5-1. Corrected signal, R'_i.

Defining a filter coefficient $\rho_i = 0.143(i)$, the general expression becomes

$$R'_i = R_i\ (1 + \rho_i \Delta E_0/E_{01})\quad E_{00}/E_{01}. \tag{5.6}$$

The ρ_i are given in table 5-2:

i	ρ_i
1	0.143
2	0.286
3	0.429
4	0.572
5	0.715
6	0.858

Table 5-2. Filter coefficients.

The raw signal data R_s are taken from the recording printer output strip (see figure 4-1) and entered on the correction work sheet (figure 5-2). The indicated operations are then performed with a hand calculator or a computer

programmed for this task. The program listing used on the Hewlett-Packard calculator and processed data printouts are included in appendix C.

5.2 SPECTRAL CALIBRATION

The factor A heading column 8 of figure 5-2 is the calibration quantity enabling conversion of relative irradiance R' to absolute irradiance. "A" has units of microwatts per volt per square centimeter ($\mu W V^{-1} cm^{-2}$); its derivation may be inferred from [illegible] endices A and B. Since the units of the R' are actually volts, it foll[illegible] that AR' yields $\mu W cm^{-2}$.

5.3 UNCORRECTED QUICK LOOK

Some of the data collected during the cruise were plotted as relative irradiance with no or minimal correction in order to provide a quick look for the author and for the chief scientist. Figure 5-3 shows a field plot of total sky illuminance on a relative 0 to 10-mV scale and also in photopic units ($lumens/ft^2$) for station 40. Sun/sky ratio is also shown. These curves show that during the data taking period, the total illuminance (and total irradiance) was increasing with the ascending sun, but that sun/sky decreased because of deteriorating atmospheric conditions (increasing haze and cloudiness). This phenomenon was not unusual during the cruise; indeed, often no shadows were observable; hence sun/sky was effectively zero at those times.

Figure 5-4 is a field plot of spectral irradiance at 488 nm versus depth for station 40. Three points of the upwelling data, Up/W, were corrected and replotted, as were two points of the downwelling data, Dn/W. Figures 5-3 and 5-4 illustrate the desirability of the correction technique described in section 5-1. Some field calculations from this and similar data for other stations were made in the field as uncorrected quick-look indications of the diffuse attenuation coefficient. Average values or $\bar{K}$ computations made over 12-m to 94-m intervals yielded values in the interval $0.03\ m^{-1} \leq \bar{K} < .1\ m^{-1}$. Since field calculations were not made at all wavelengths and were made for relatively long paths, the $\bar{K}$ values cited are not necessarily indicative of any $K(\lambda)$. The results of calculations from corrected data will be given in section 6.0, Data Presentation.

6.0 DATA PRESENTATION

6.1 SPECTRAL IRRADIANCE VERSUS DEPTH

Spectral irradiance, $E(\lambda)$, versus depth (Z) for each station is plotted in figures 6-1 to 6-12 inclusive. The program used and the processed data printouts are included in appendix C. Straight-line fits adequately represent the measurements in most cases. The effects of bottom reflectance on the upwelling measurements at station 43 are evident in figure 6-6 at depths $\geq$20 m. Bottom depth was 31 m at this site. Difficulty in fitting continuous straight lines to the Up/W data at station 51, figure 6-10, is thought to be at least partially due to the reflectance of the 27-m bottom.

DATA SHEET
11ND NOSC-5220/1 (4-77)

TITLE

NOAACZCS Cruise 80-01 Irradiance Data Correction Work Sheet

DATE

Sta. #

Dn/W: Up/W:

Dark Reading (R_D) =

Initial Deck Cell E_{00} =

Fil. No.	ρ_1	A($\mu W\ V^{-1} Cm^{-2}$)
6	.858	
5	.715	
4	.572	
3	.429	
2	.286	
1	.143	

		1	2	3	4	5	6	7	8	9
Depth Z(m)	Fil. #	Raw Sig. R_S	Net Sig. $R=R_S-R_D$	Deck Cell E_{0Z}	$\frac{E_{00}}{E_{01}}$	$\frac{\Delta E_0}{E_{01}}$	$1+\rho_i \cdot$ 5	R' = 2·4·6	AR' ($\mu W\ Cm^{-2}$)	Log AR' ($\mu W\ Cm^{-2}$)
	1									
"	2				"	"				
"	3				"	"				
"	4				"	"				
"	5				"	"				
"	6				"	"				
	1									
"	2				"	"				
"	3				"	"				
"	4				"	"				
"	5				"	"				
"	6				"	"				
	1									
"	2				"	"				
"	3				"	"				
"	4				"	"				
"	5				"	"				
"	6				"	"				

OBSERVERS SHEET OF SHEETS

Figure 5-2. Data correction work sheet.

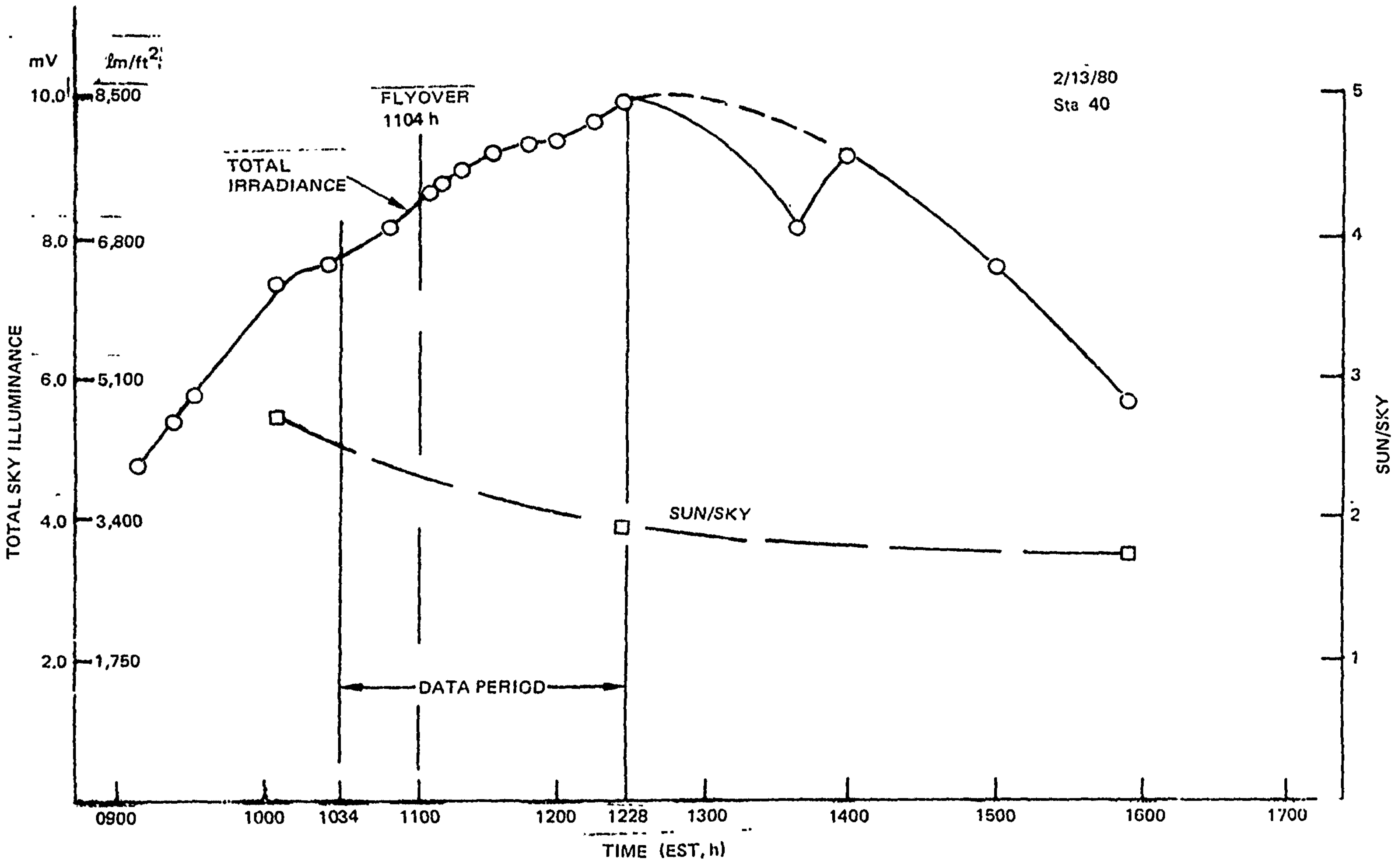


Figure 5-3. Field plot of total sky illuminance.

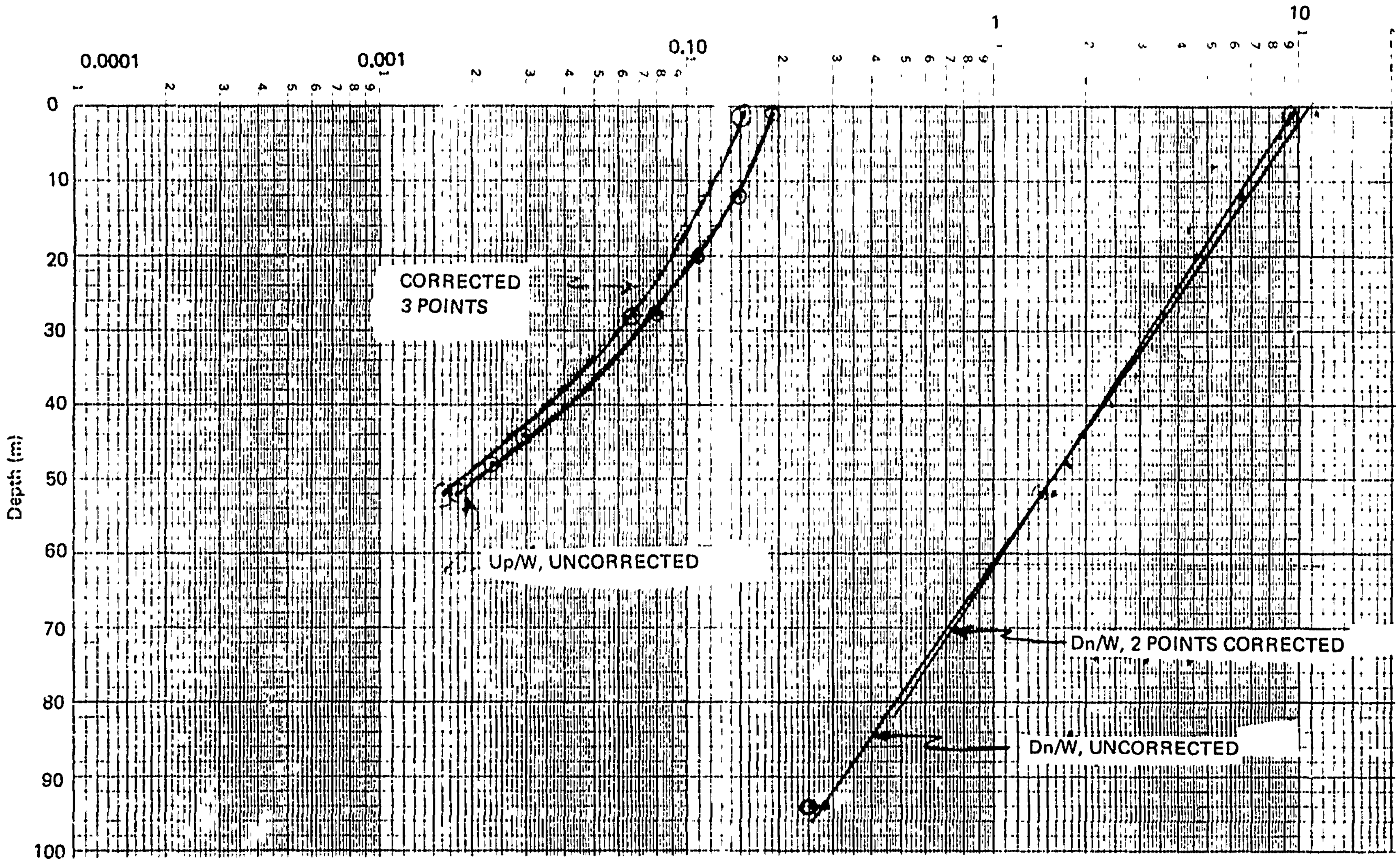


Figure 5-4. Spectral irradiance at 488 nm, station 40.

6.2 SPECTRAL DIFFUSE ATTENUATION COEFFICIENTS

Spectral diffuse attenuation coefficient, k(λ), for both upwelling (Up/W) and downwelling (Dn/W) measurements were computed from figures 6-1 to 6-12 and are tabulated in table 6-1.

Station		λ1 440 nm	λ2 488 nm	λ3 500 nm	λ4 520 nm	λ5 550 nm	λ6 670 nm
15	Up/W	0.329	0.21	0.187	0.17	0.144	--[2]
	Dn/W	0.32	0.23	0.209	0.196	0.181	0.461
40	Up/W	0.064	0.058	0.054	0.064	0.062	--[2]
	Dn/W	0.039	0.035	0.039	0.056	0.075	0.073
43	Up/W	0.161	0.078	0.076	0.087	0.102	--[2]
	Dn/W	0.112	0.085	0.085	0.105	0.112	0.512
47	Up/W	0.058	0.05	0.05	0.072	0.103	--[2]
	Dn/W	0.068	0.056	0.059	0.079	0.094	--[2]
51	Up/W	0.052	0.041	0.043	0.042	0.041	--[2]
	Dn/W	0.035	0.025	0.031	0.051	0.065	0.512
55	Up/W	0.115	0.066	0.092	0.112	0.144	--[2]
	Dn/W	0.111	0.084	0.096	0.10	0.096	0.50

[1] Computation equation: $K(\lambda) = \dfrac{\Delta \log[E(\lambda)_z/E_o]}{0.434\Delta Z}$

[2] Inadequate sensitivity in Up/W channel for K(670) determination.

Table 6-1. Spectral diffuse attenuation coefficients K(λ)[1].

7.0 SHORTCOMINGS

Probably the most far-reaching limitation of these data derives from the phenomenon over which we have the least control; that is, atmospheric conditions. Most days were partially or completely overcast, as indicated in table 2-1. It appears unlikely that significant remote versus in situ correlation can be obtained for most of the data.

A second problem area, also weather-related, was that of rapid changes in surface ambient irradiance. Although this was monitored and periodically

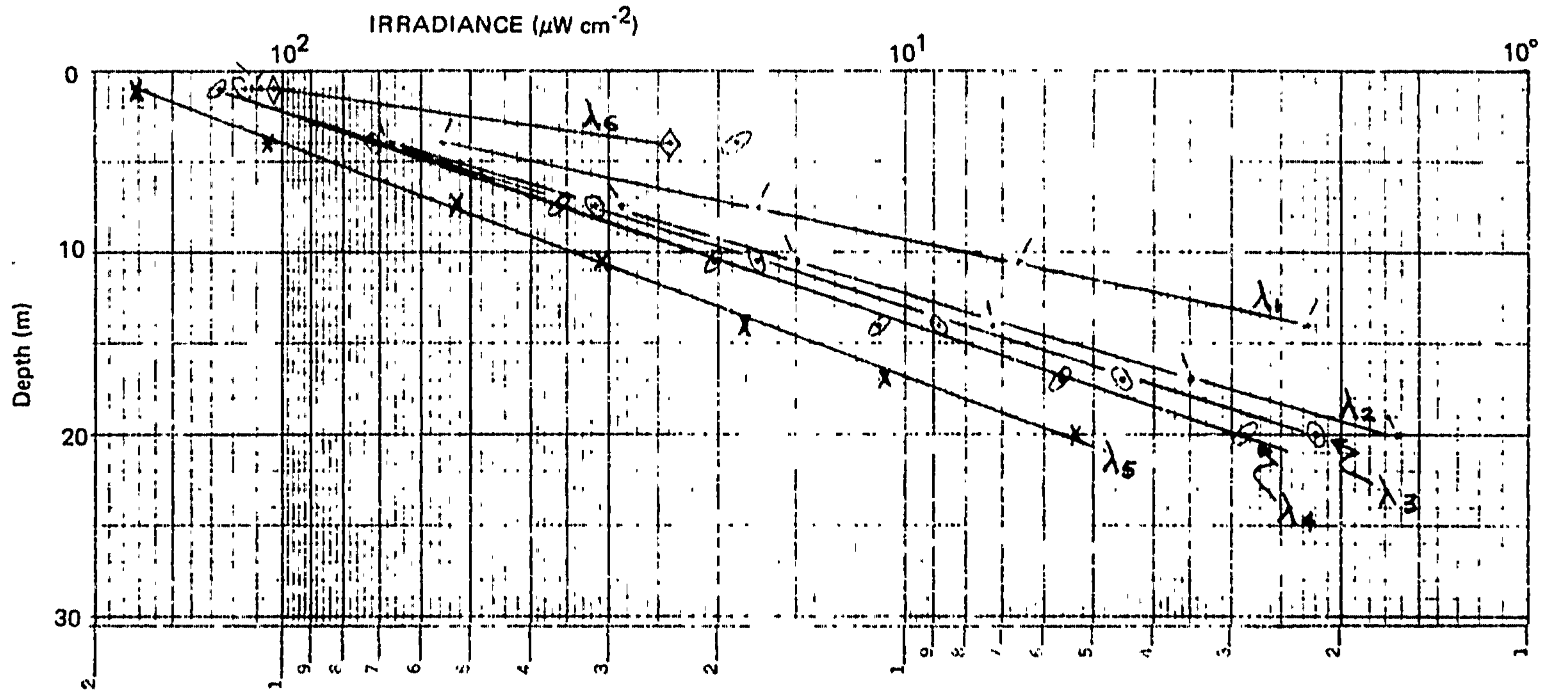


Figure 6-1. Spectral irradiance versus depth for station 15, Dn/W.

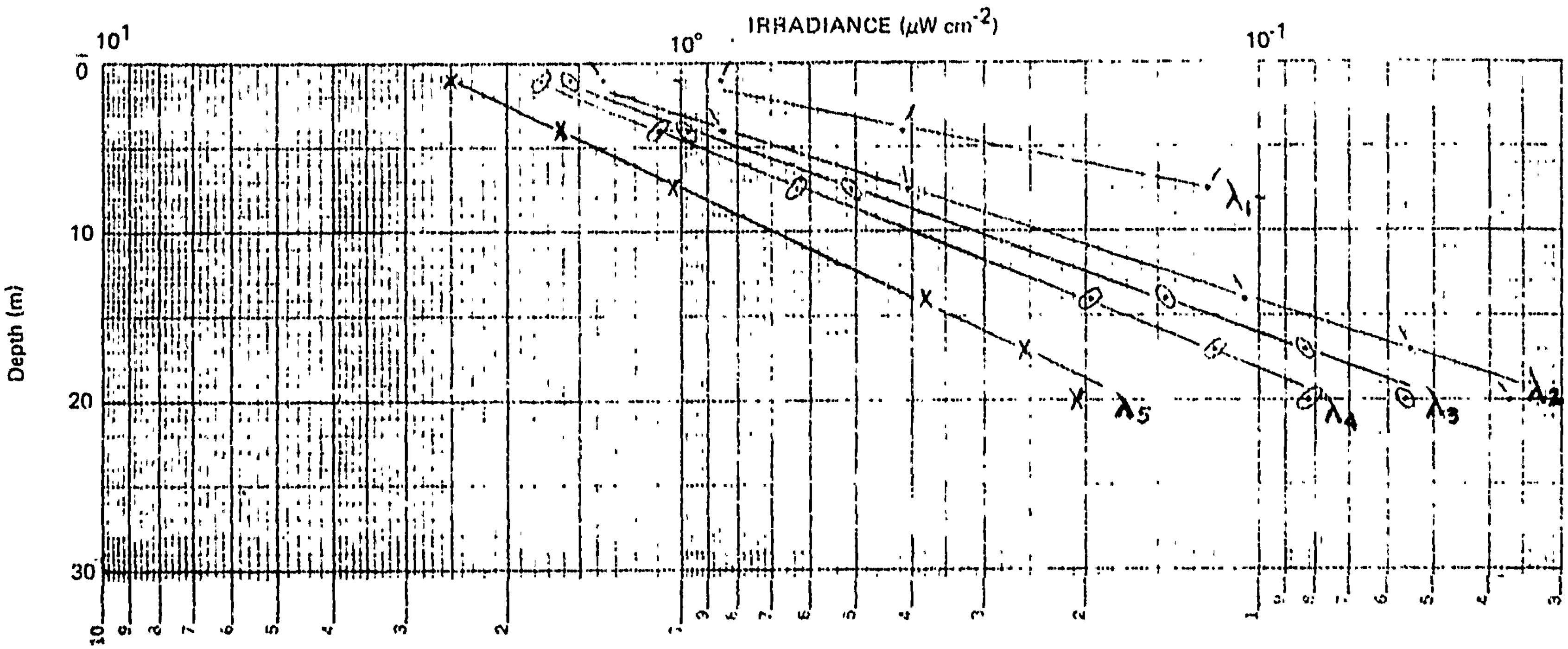


Figure 6-2. Spectral irradiance versus depth for station 15, Up/W.

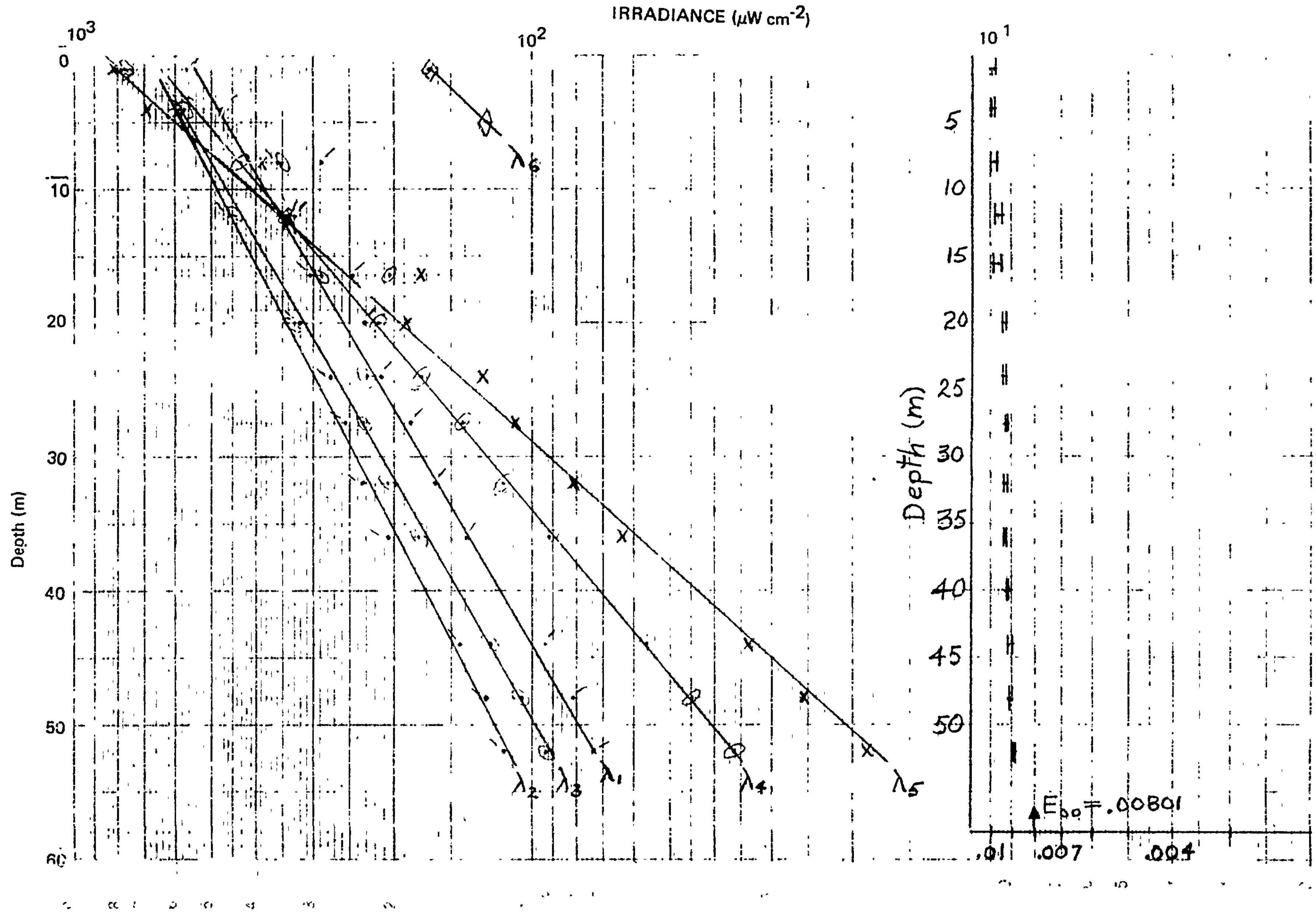


Figure 6-3. Spectral irradiance versus depth for station 40, Dn/W.

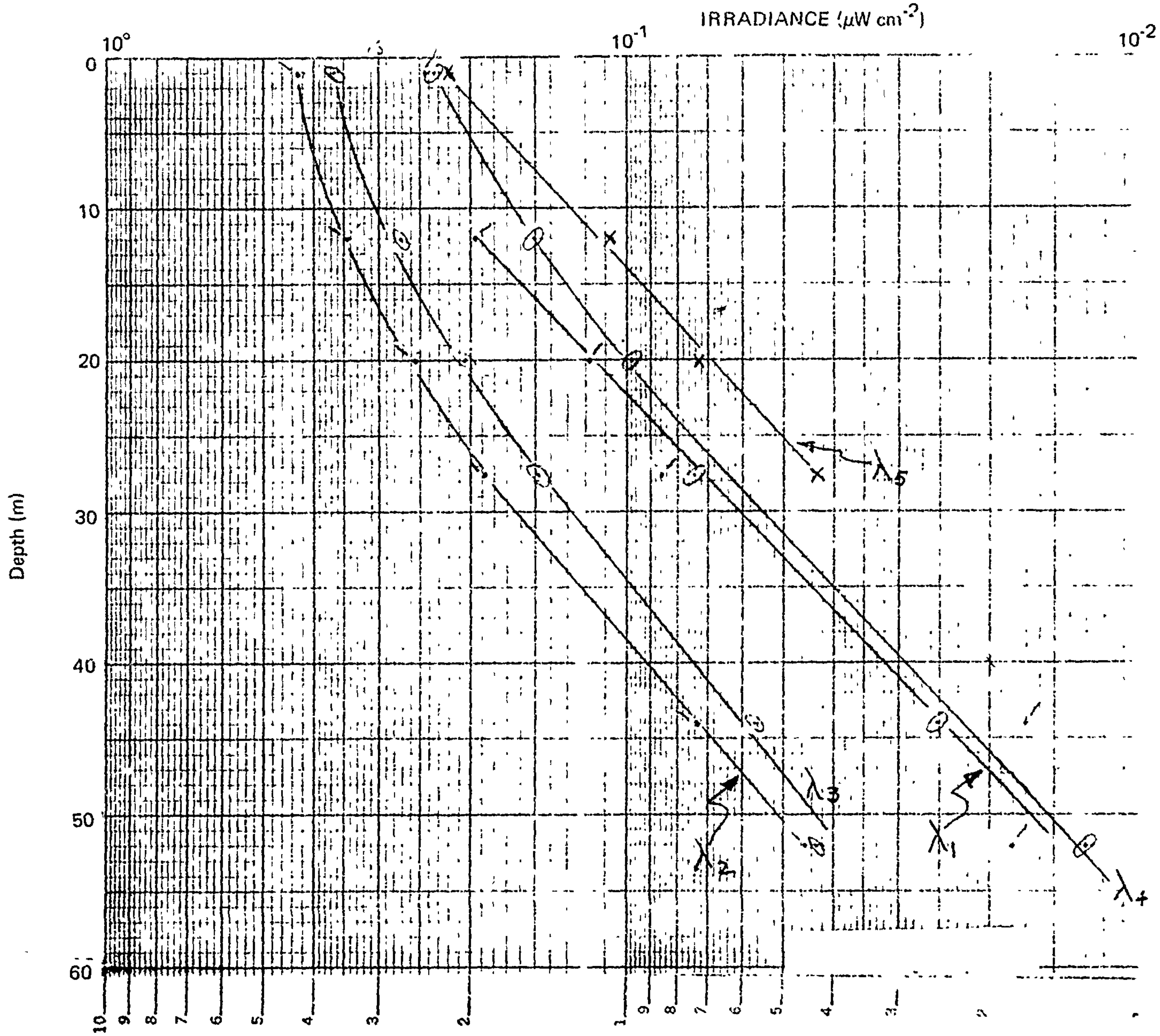


Figure 6-4. Spectral irradiance versus depth for station 40, Up/W.

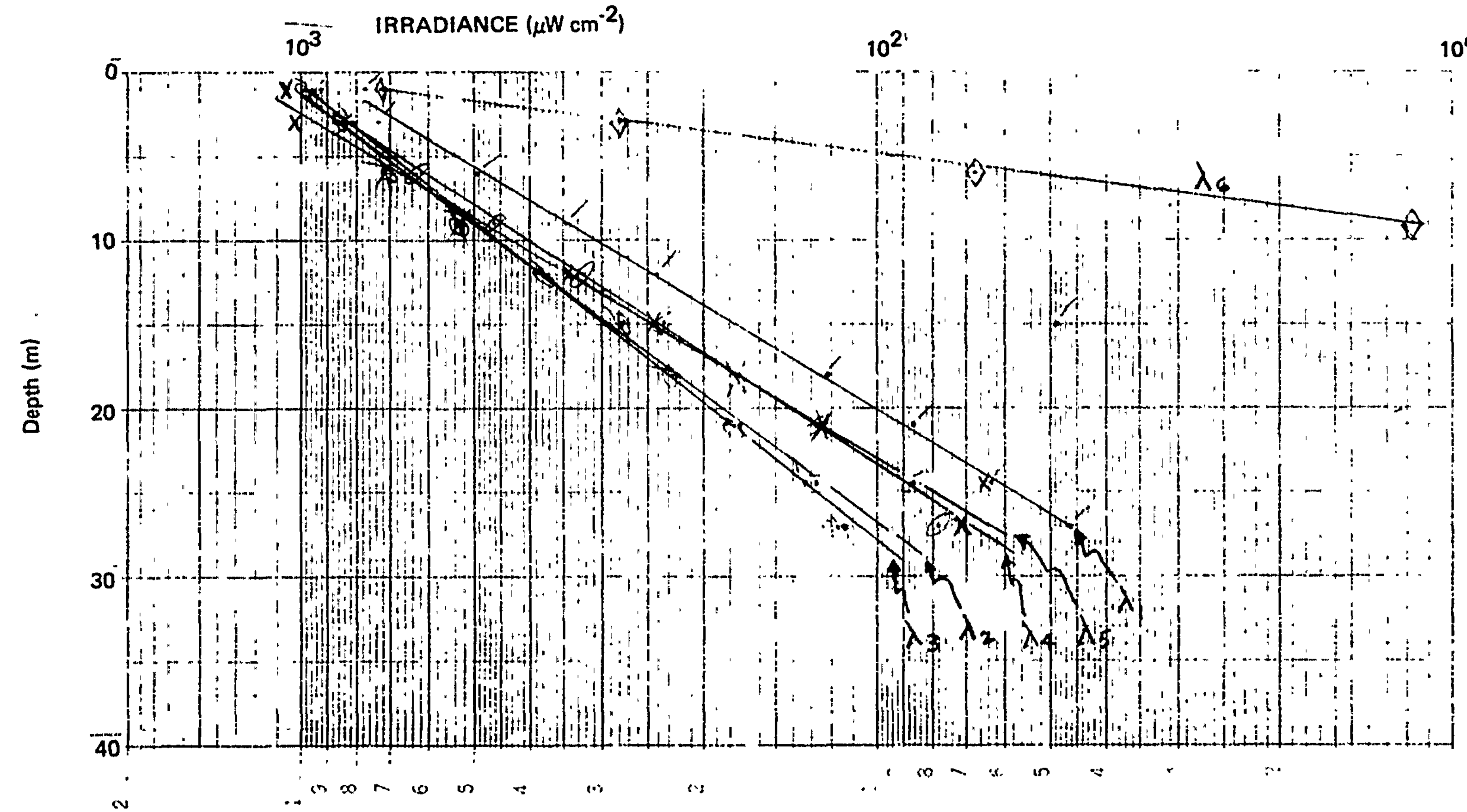


Figure 6-5. Spectral irradiance versus depth for station 43, Dn/W.

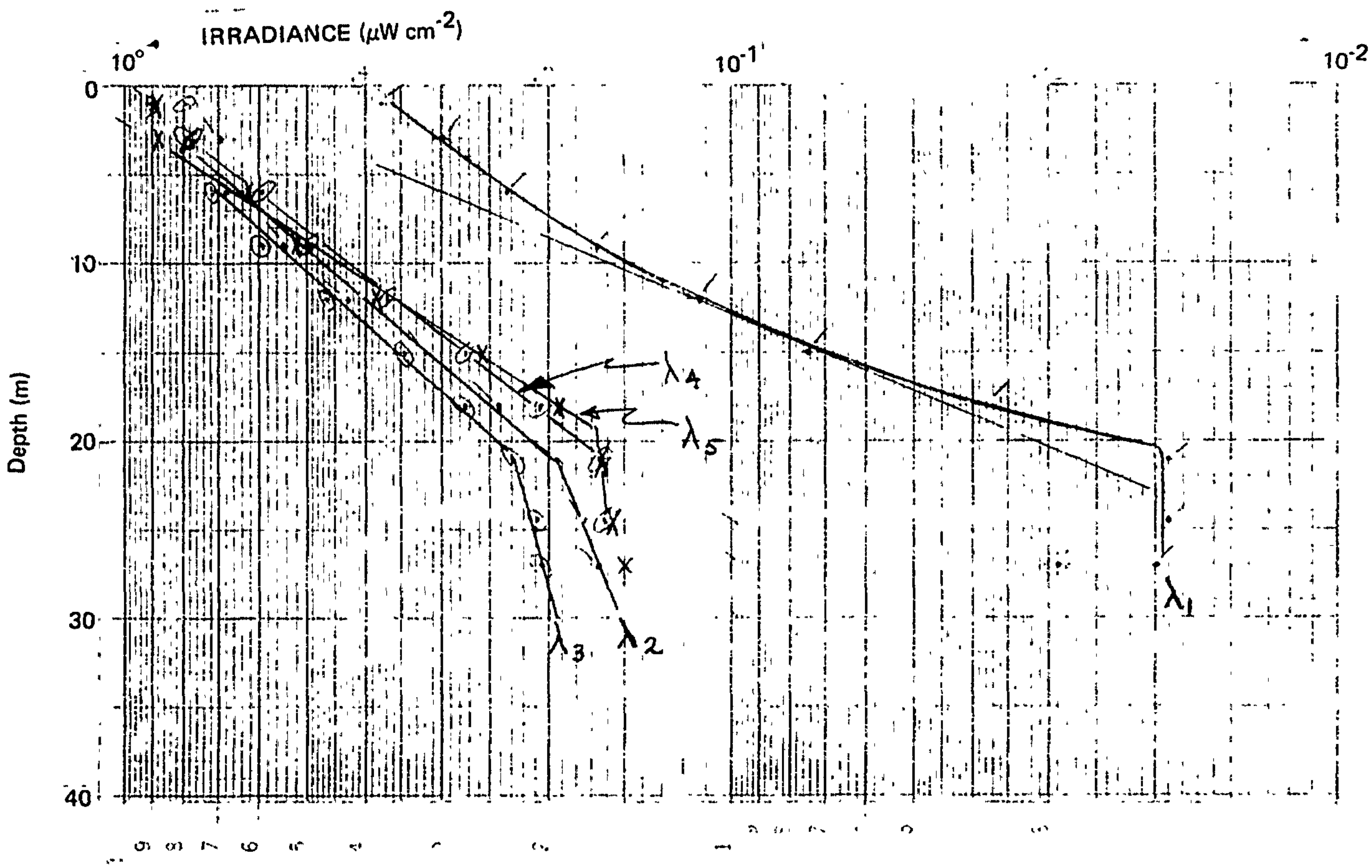


Figure 6-6. Spectral irradiance versus depth for station 43, Up/W.

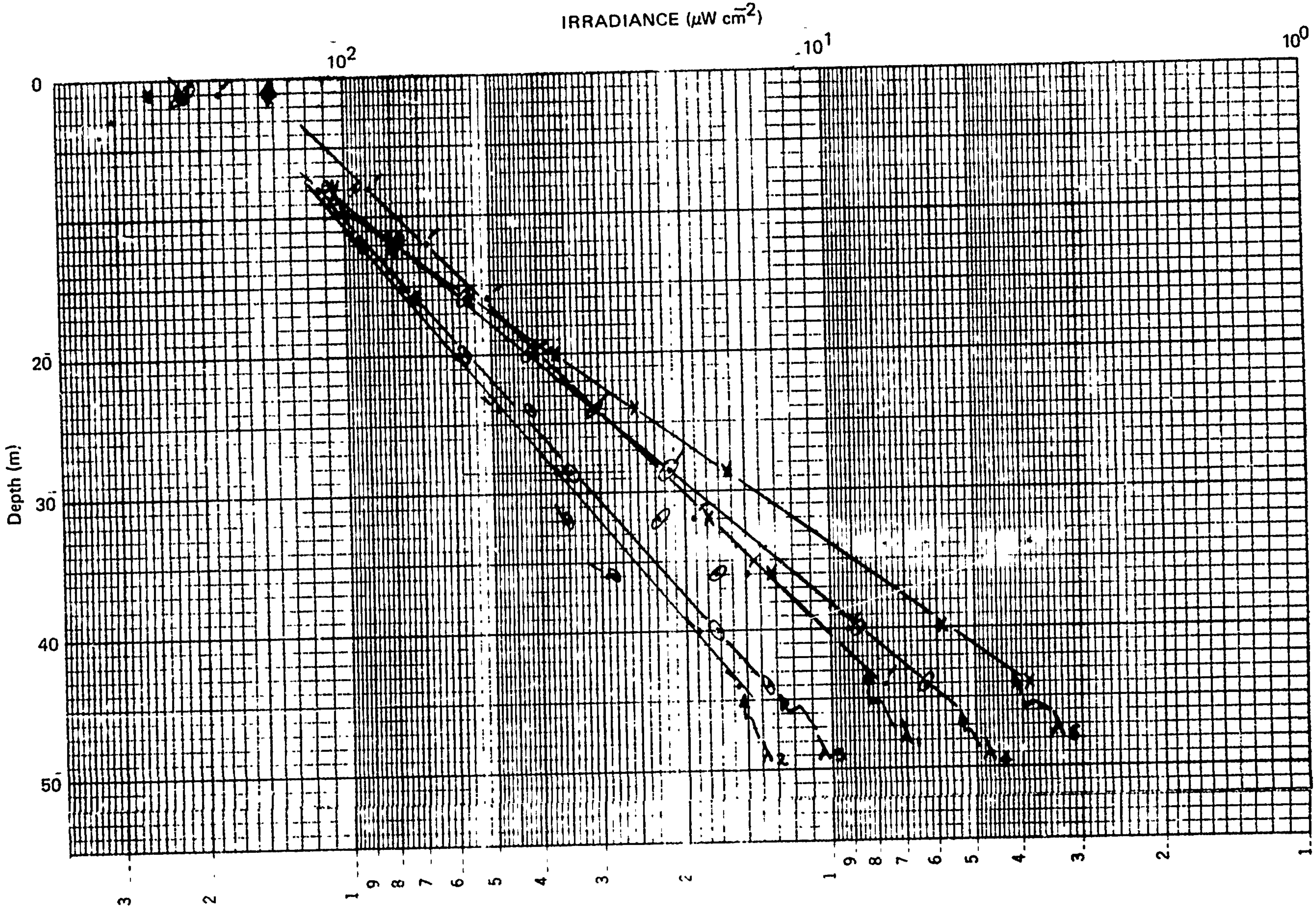


Figure 6-7. Spectral irradiance versus depth for station 47, Dn/W.

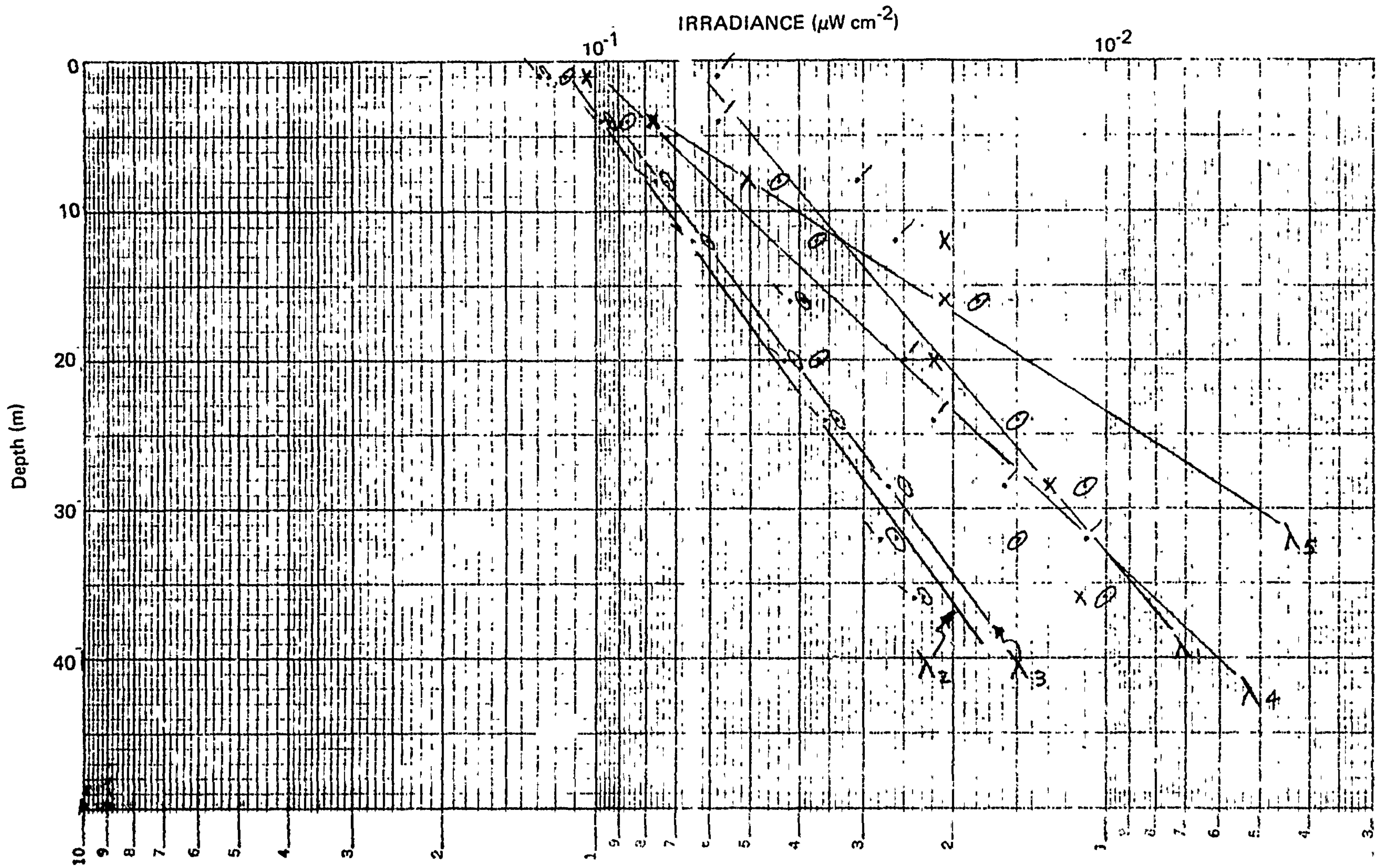


Figure 6-8. Spectral irradiance versus depth for station 47, Up/W.

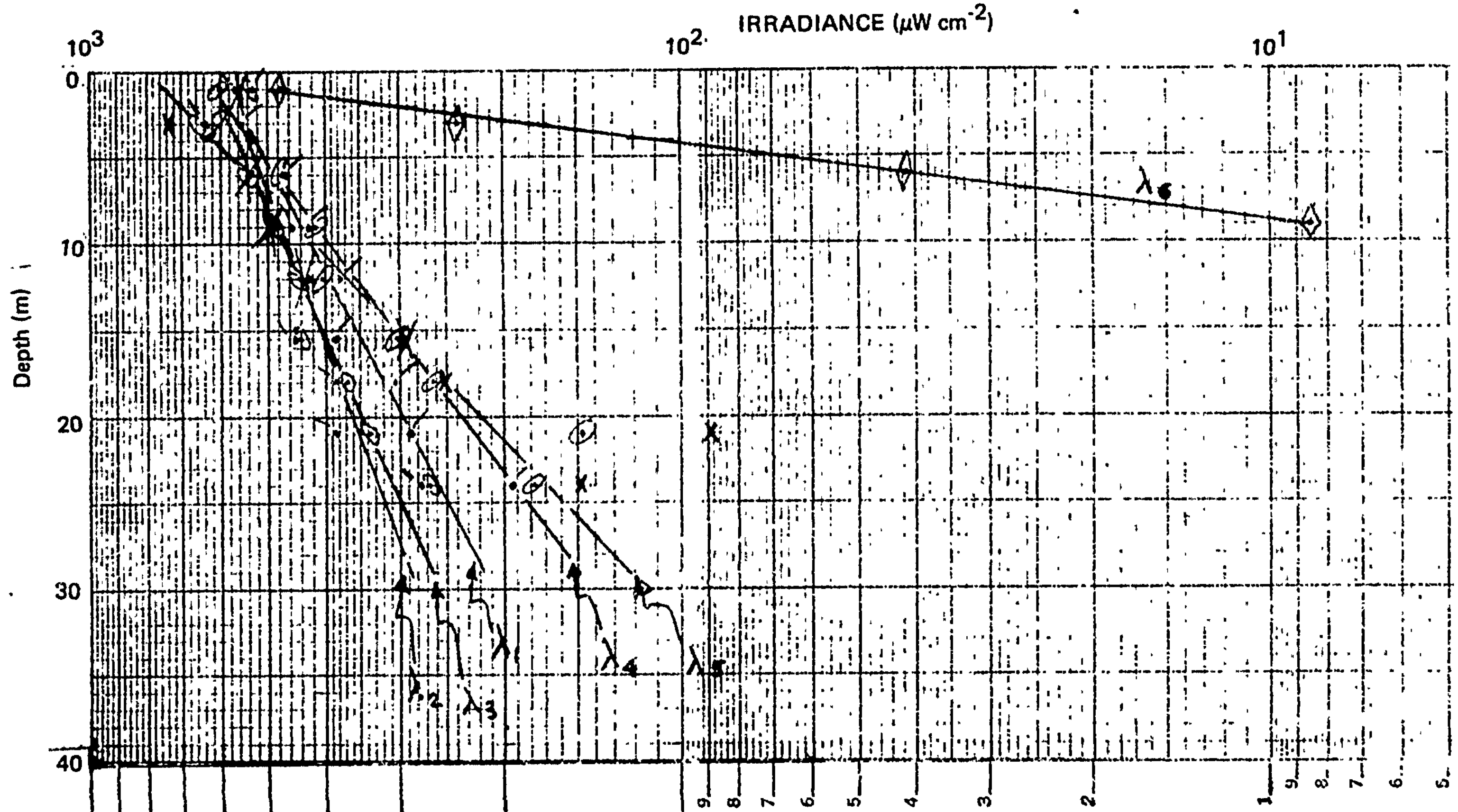


Figure 6-9. Spectral irradiance versus depth for station 51, Dn/W.

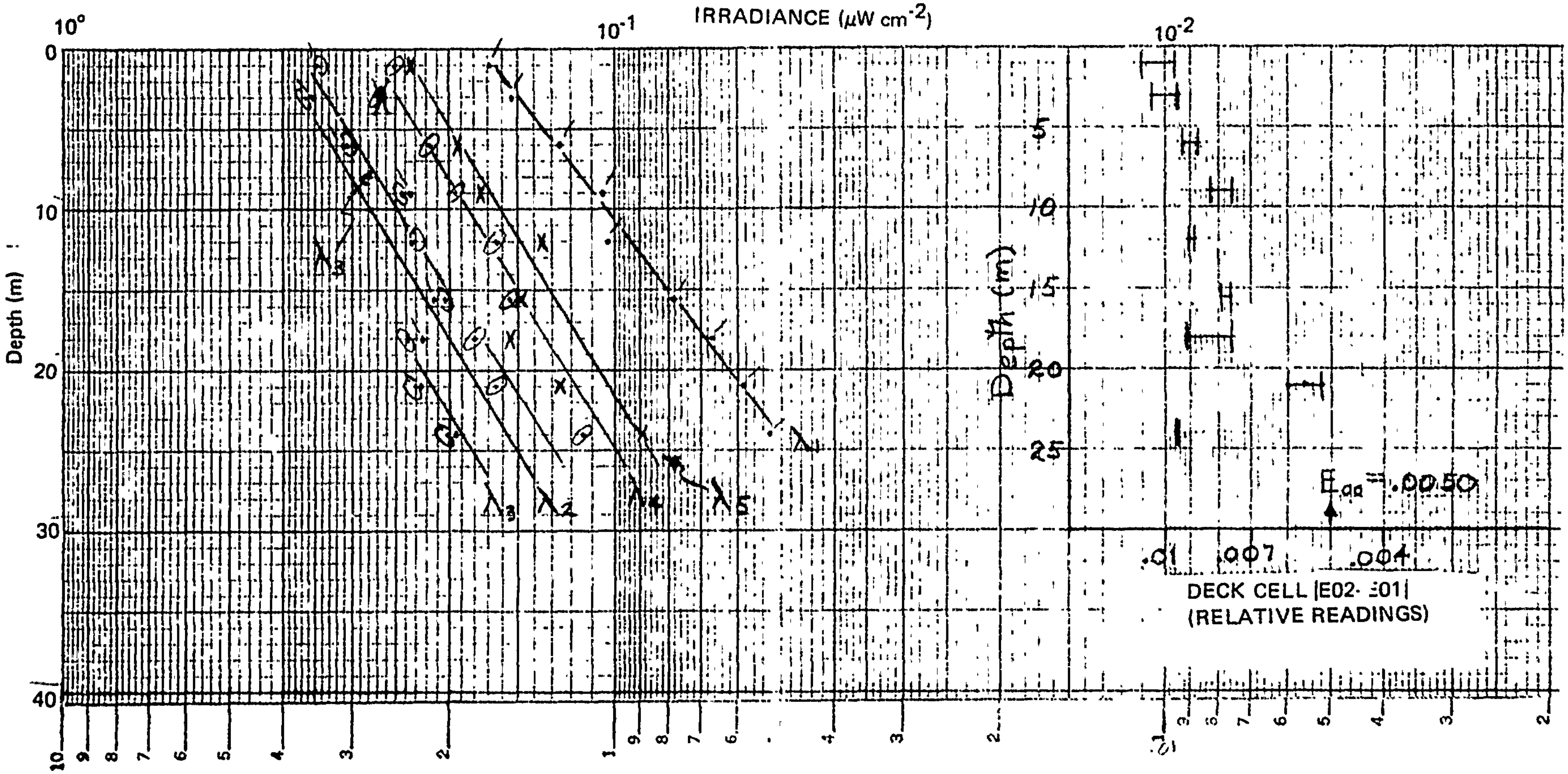


Figure 6-10. Spectral irradiance versus depth fo station 51, Up/W.

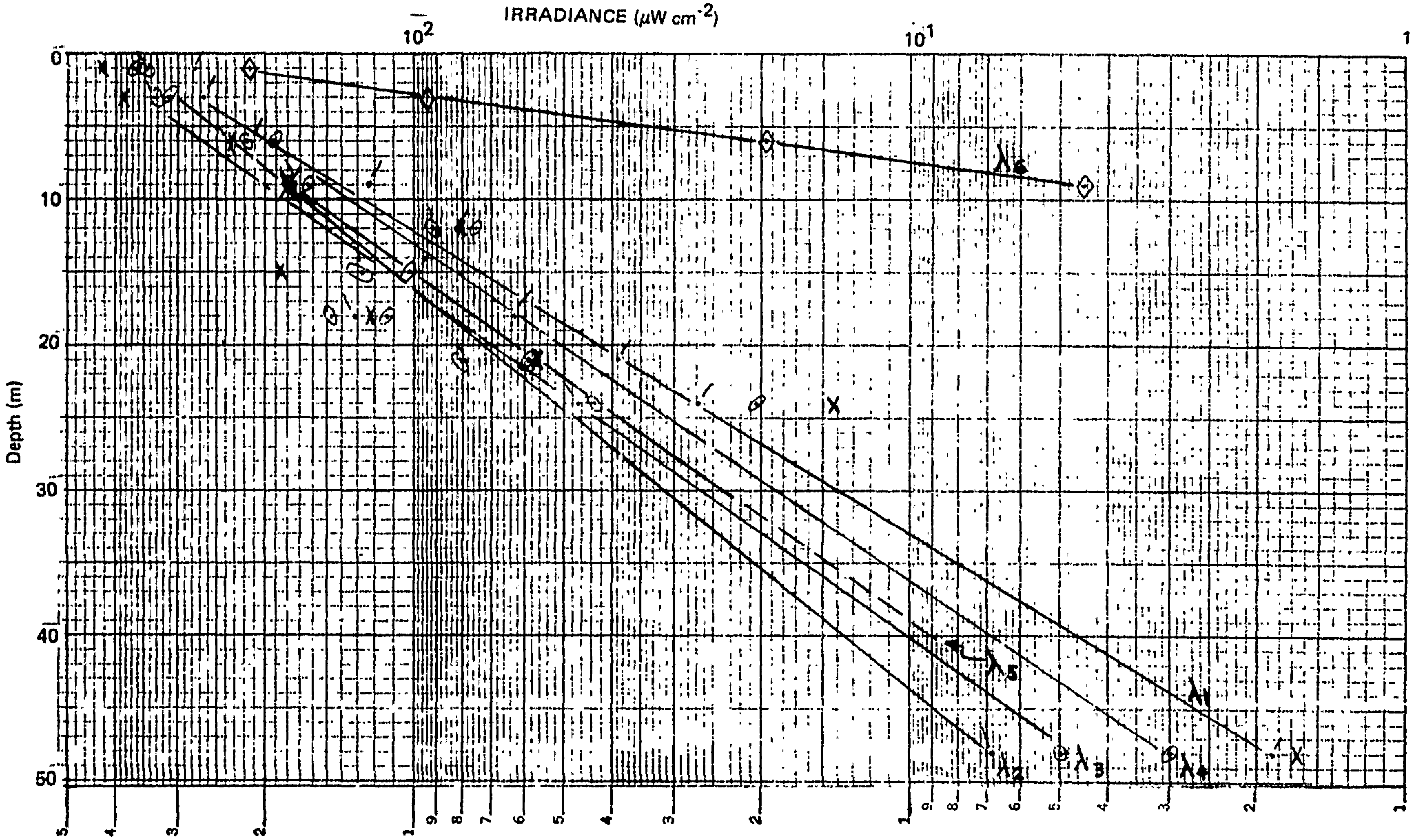


Figure 6-11. Spectral irradiance versus depth for station 55, Dn/W.

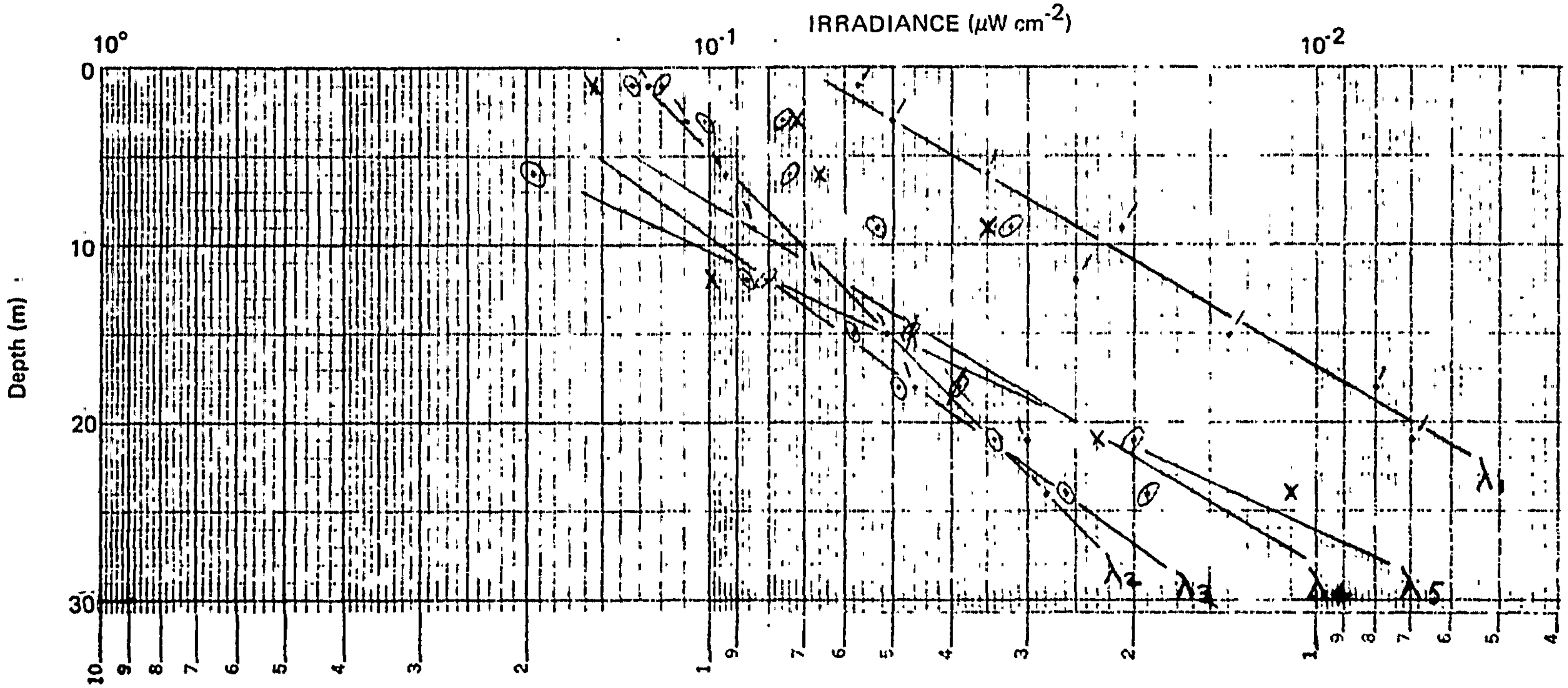


Figure 6-12. Spectral irradiance versus depth for station 55, Up/W.

recorded as previously discussed in sections 3 and 4 and the correction algorithm of section 5.1 was applied, there were situations when large and rapid changes in ambient occurred during a measurement sequence. These were at best only partially corrected by the algorithm, and in a few cases error could have been inserted by the algorithm. Station 55 at 24-m depth (Dn/W) illustrates the situation described; here E_{o1} = 0.00995 at the start and E_{o2} = 0.00328 at the end of the measurement sequence. Refer to equation (5.2) of section 5.0 and to the listing in appendix C to see the algorithm and its effect (CORR SIG versus NET SIG) when attempting to correct for the large, rapid ambient change. This shortcoming can and should be eliminated by electronically normalizing the channel signal to the deck cell signal coincident with data recording. This equipment improvement is planned for the NOSC spectral irradiance meter.

8.0 CONCLUSIONS AND RECOMMENDATIONS

These remarks must be considered as interim pending more extensive examination, comparison, interpretation, and possible correlation between these spectral irradiance data, other measurements made on board ALBATROSS IV, and the remote spectral measurements taken from the NIMBUS VII satellite. Nevertheless, some items appear obvious:

a. Comparison and possible correlation among spectral irradiance, spectral K, and chlorophyll and/or suspended matter should be attempted since hydrocasts were made at five of the six stations where spectral irradiance measurements were made (table 2-1).

b. Possible correlation between the irradiance data and water temperature should be examined. Complete XBT charts are available for this. A preliminary look based on the author's hand copies of the XBT charts (appendix E) suggest that a correlation may exist where thermocline structure is significant. See the irradiance plot for station 40, Up/W (figure 6-4) and the XBT traces (appendix E) in the neighborhood of 25 m depth.

This comparison is all the more significant because the surface ambient illumination was relatively constant at station 40 (see figure 6-3), sea state was moderate at 1, and Beaufort wind force was 3 (7 to 10 knots). In addition, it is interesting that no significant effect is observable in the downwelling data for station 40 (figure 6-3).

It is the author's belief that awareness of and implementation of these recommendations will improve the quality and quantity of in situ ocean measurements to be made on future cruises having purposes similar to those of NOAACZCS 80-01.

Measurement process/technique - Use of the ship's electronics laboratory as the control site for the radiometric work performed proved highly satisfactory and is recommended for future cruises. Environmental protection for the control and recording equipment, good access to the upper deck (overlooking the after main deck where the deck technicians handled the underwater unit assembly) as well as to the top after deck where the deck cell was stationed,

and sufficient remoteness from the work and activity of the biological laboratories all contributed to a highly efficient operation. Communication was good by means of ship's intercom to the bridge and hand radios (walkie-talkies) during the measurement period. Sufficient bench and electronics rack space, as well as bulkhead ports for the instrumentation cables, were available.

It was determined during the cruise that the Secchi depth could be used as a fairly good indication of the euphotic depth. The rule of thumb evolved was euphotic depth $\approx$ 4 Secchi depth for measurements at 488 nm and at 500 nm (filters 2 and 3). It is therefore recommended that the Secchi disk measurement be made as shown in table 4-1; ie, prior to submerging the underwater radiometer. Because of the subjectivity of the Secchi observation measurement, it is preferable to assign one observer for this task.

Measurement equipment - Significant modifications in the underwater irradiance meter are needed to improve the quality of the measurements, to increase the depth resolution of the irradiance measurements, and to reduce the required time on station. An outline of the recommended modifications is given in table 8-1. These modifications are projected for the NOSC spectral irradiance meter; a cost estimate from the manufacturer has been requested.

Operator training - In the event the National Bureau of Fisheries chooses to purchase and field its own underwater spectral irradiance meter, it would be advantageous and cost-effective to provide operator orientation and training in consort with experienced NOSC personnel. This could be accomplished by contracting for NOSC participation on another cruise with Fisheries personnel initially assisting and ultimately operating the equipment.

Another possibility might be Fisheries personnel accompanying a NOSC field effort in which the spectral irradiance meter would be used. It is the author's opinion that the preceding recommendation would be more effective for Bureau of Fisheries purposes because working conditions, support equipment, site location, and possibly even frequency of use of the equipment of interest could be significantly different on a NOSC field project than on a Fisheries cruise. It is further suggested that recommendations from Cruise 80-01 Chief Scientist R. Marak be solicited in this matter.

1. Normalization Capability. Divide each channel signal by the deck cell monitor signal. The initial deck cell reading, E_{oo}, is to be stored and applied to each channel signal to form $R'_i = E_{oo} R_i/E_o$, where R_i is the i^{th} channel signal, $1 \leq i \leq 6$, E_o is the deck cell monitor signal, and R'_i is the corrected signal which is to be recorded.

2. Over-Flux Protection and Indication. Provide high-voltage turnoff whenever $R_i > 10V$; also provide indicator light and reset button.

3. Normalization Capability, Multiple Deck Cells. Same as recommendation 1 except that up to six deck cells could be used, one for each channel. Here $R'_i = E_{oo} R_i/E_{oi}$. An analog I/O board with a minimum of eight single-ended inputs also would be desirable here.

4. Temperature Sensor. Provide the capability of measuring and recording the ambient water temperature (°C).

5. Analog Output for Depth Transducer. Use this to drive XY recorder.

6. Analog Log Ratio Output. Use this to output log base 10 of R'_i for either 1 or 3 above. This output would be applied to XY recorder referred to in (5).

7. Voltage-to-frequency Detector Assembly with High-Voltage Adjust for Extended Dynamic Range. This option would allow utilization of the maximum sensitivity of the underwater sensor without the awkward and time-consuming necessity of removing optical attenuation filters. The over-flux protection 5 must be functional with this option. Some indication of the high-voltage range in use for the operator and for the tape data record must be provided to permit data reduction.

8. Count Indicator Light. Placed adjacent to the LCD readout, this light would be on when analog output signal is presented for any channel.

9. Control Console. A unit with keyboard entry, CRT display, and tape cassette record and playback might be the most cost-effective means of implementing relevant recommendations above. This is presently under consideration.

Table 8-1. Recommended modifications to the SE-267 six-channel underwater radiometer system.

APPENDIX A

INSTRUMENT CALIBRATION

APPENDIX A

INSTRUMENT CALIBRATION

The radiometric measurement instrumentation used on NOAACZCS Cruise 01 was calibrated prior to and after the cruise. The radiometric laboratory facility at NOSC was used for the calibrations requiring controlled and repeatable illumination. An Eppley working-standard lamp traceable to National Bureau of Standards spectral characteristics was used as the calibration reference source for both the spectral irradiance meter and the deck cell. No correction has been made for the "immersion factor" which would affect the accuracy of the calibration by some 10 to 20% for underwater measurements.

No claim is made as to the absolute accuracy of the irradiance measurements. From checks made during the NOSC calibrations, it was found that factors affecting the repeatability and stability of the irradiance meter contributed to a relative error of no more than $\pm$ 3%. It is this figure, not the absolute accuracy error, that impacts on the values for $k(\lambda)$ determined in table 6-1.

The depth transducer was calibrated prior to the cruise. An Ametek model T-3 comparator pressure meter was used to perform the calibration. Accuracy is within $\pm$ 0.6 m at any depth.

APPENDIX B

SPECTRAL FILTER CHARACTERISTICS

SPECTRAL FILTER CHARACTERISTICS
NOAACZCS Cruise 80-01

Filter No	Nominal Value (Edge Designate)	λ_c (nm)	$\Delta\lambda$ (nm)	Peak Transmittance
1	440	439.6	7.3	T = 0.45
2	488	487.8	6.5	T = 0.52
3	500	501.2	7.1	T = 0.51
4	520	520.9	8.1	T = 0.63
5	550	552.9	10.5	T = 0.65
6	670	668.8	11.8	T = 0.60
	Wratten 102	559	105	Deck cell, photopic $\hat{T}$ = 0.67

Measurements made on Cary spectrophotometer from $380 \leq \lambda \leq 300$ nm.

APPENDIX C

DATA FORMAT, PROGRAM, AND DATA LISTINGS

DATA FORMAT

Start:

- o Line up bottom of paper strip to START near bottom of printer.

o	Deck cell	2 entries
	Space	3
o	Place filter position switch in 7.	
o	Filter 1	2
	Space	1
	Filter 2	2
	Space	1
	Filter 3	2
	Space	1
	Filter 4	2
	Space	1
	Filter 5	2
	Space	1
	Filter 6	2
	Space	1
o	Place filter position switch in 6.	
	Deck cell	2 entries.
o	Space	6 spaces

t = 1422 hrs end

Time for 1 data set at each depth ≈ 5.5 min.

.000301 Deck
.000301 Cell

.004977 F6
.004519

1

.003357 F5
.003357

1

UP/W
D = 6m

.003351 F4
.003351

1

.003358 F3
.003358

1

.003358 F2
.002727

1

.002747 F1
.002744

3 sp

1/15/80

.030181 Deck
.030181 Cell

SAMPLE DATA RUN

.030191 Deck
.030190 Cell

3 sp

DN/W
D = 6m

.030607 F6
.030606

1

.021666 F5
.015147

1

.018000 F4
.017999

1

.014345 F3
.014340

1

.010066 F2
.010065

1

.006420 F1
.006420

3 sp

1/15/80

.031425 Deck
.031420 Cell

1416 hrs. start

Program Listing

R260

Run on HP 9820A Calculator

```
0:
SPC 2;PRT "NOAAC
ZCS 80-01";SPC 2
⊢
1:
ENT "STA NO.?",A
;PRT "STA NO.=";
FXD 0;PRT A;SPC
⊢
2:
ENT "1=UP,0=DOWN
",A;IF A=1;PRT "
UP/W";SPC ⊢
3:
IF A=0;PRT "DN/W
";SPC ⊢
4:
ENT "DEPTH?",A;
FXD 1;PRT "DEPTH
=",A;SPC ⊢
5:
FXD 6;ENT "RD=",
Z;PRT "RD=",Z;
ENT "E00?",R0;
PRT "E00=",R0⊢
6:
ENT "E01?",R1;
PRT "E01=",R1;
ENT "E02?",R2;
PRT "E02=",R2;
SPC ⊢
7:
PRT "RAW SIG ="⊢
8:
ENT "1?",R3;PRT
R3;ENT "2?",R4;
PRT R4;ENT "3?",
R5;PRT R5⊢
9:
ENT "4?",R6;PRT
R6;ENT "5?",R7;
PRT R7;ENT "6?",
F ⊢
10:
.143→R11;.286→R1
2;.429→R13;.572→
R14;.715→R15;.85
8→R16⊢
11:
298E-6→R31⊢
12:
128.8E-6→R32⊢
13:
115.5E-6→R33⊢
14:
103.6E-6→R34⊢
15:
126.2E-6→R35⊢
16:
9992E-6→R36⊢
17:
R3-Z→R3;R4-Z→R4;
R5-Z→R5;R6-Z→R6;
R7-Z→R7;R8-Z→R8;
PRT "NET SIG="⊢
18:
PRT R3,R4,R5,R6,
R7,R8;SPC ⊢
19:
(R2-R1)/R1→R9;R0
/R1→R10⊢
20:
1+R9R11→R21;1+R9
R12→R22;1+R9R13→
R23;1+R9R14→R24⊢
21:
1+R9R15→R25;1+R9
R6→R26⊢
22:
R3R10R21→R3;R4R1
0R22→R4;R5R10R23
→R5⊢
23:
R6R10R24→R6;R7R1
0R25→R7;R8R10R26
→R8⊢
24:
PRT "CORR SIG=",
R3,R4,R5,R6,R7,R
8;S
25:
R31R3→R3;R32R4→R
4;R33R5→R5;R34R6
→R6⊢
26:
R35R7→R7;R36R8→R
8;PRT "MICRO-WAT
TS CM-2"⊢
27:
PRT 1E6R3,1E6R4,
1E6R5,1E6R6,1E6R
7,1E6R8;SPC ⊢
28:
PRT "LOG MICRO-W
ATTS CM-2"⊢
29:
IF R3≤0;PRT 0;
JMP 2⊢
30:
PRT LOG (1E6R3)⊢
31:
IF R4≤0;PRT 0;
JMP 2⊢
32:
PRT LOG (1E6R4)⊢
33:
IF R5≤0;PRT 0;
JMP 2⊢
34:
PRT LOG (1E6R5)⊢
35:
IF R6≤0;PRT 0:
JMP 2⊢
36:
PRT LOG (1E6R6)⊢
37:
IF R7≤0;PRT 0;
JMP 2⊢
38:
PRT LOG (1E6R7)⊢
39:
IF R8≤0;PRT 0;
JMP 2⊢
40:
PRT LOG (1E6R8)⊢
41:
GTO 4;SPC 3⊢
R260
```

NO....... 20-01

S H NO.= 15

DK W

DEPTH= 0.0

RD= 000315

E00= .001900

E01= .001760

E02= .001900

RAW SIG =
.740000
1.424000
1.560000
1.846000
1.956000
.023500

NET SIG=
.739685
1.423685
1.559685
1.845685
1.955685
.023185

CORR SIG=
.807607
1.571898
1.741209
2.083160
2.231328
.028704

MICRO-WATTS CM-2
240.666822
202.460448
201.109622
215.815339
281.593625
286.809905

LOG MICRO-WATTS
2.381416
2.306340
2.303433
2.334082
[illegible] 149623
457594

DEPTH= 2.0

RD= .000315

E00= .001900

E01= .001960

E02= .002060

RAW SIG =
.434800
.910900
1.016000
1.217000
1.317000
.012500

NET SIG=
.434485
.910585
1.015685
1.216685
1.316685
.012185

CORR SIG=
.424257
.895590
1.006143
1.213860
1.322940
.012545

MICRO-WATTS CM-2
126.428695
115.352032
116.209531
125.755888
166.955038
125.351919

LOG MICRO-WATTS
2.101846
2.062025
2.065242
2.099528
2.222600
[illegible] 398131

DEPTH= 20.0

RD= [illegible]0315

E00= .001900

E01= .001550

E02= .001470

RAW SIG =
.000926
.010680
.016180
.023500
.036300
.000313

NET SIG=
.000611
.010365
.015665
.023185
.035985
-.000002

CORR SIG=
.000743
.012518
.019017
.027581
.042483
-.000002

MICRO-WATTS CM-2
.221545
1.612310
2.196442
2.857421
5.361332
-.024467

LOG MICRO-WATTS
-.654538
.207449
.341720
.455974
.729273
[illegible]30000

Best Available Copy

Sta. 15, Dn/W

DEPTH=
17.0
RD=
.000315
E00=
.001900
E01=
.001480
E02=
.001440
RAW SIG =
.002160
.021670
.030810
.043640
.063750
.000314
NET SIG=
.001845
.021355
.030495
.043325
.063435
-.000001
CORR SIG=
.002359
.027203
.038695
.054760
.079863
-.000001
MICRO-WATTS CM-2
.703109
3.503784
4.469281
5.673144
10.078725
-.012813
LOG MICRO-WATTS
-.152977
.54453[illegible]
.65023[illegible]
.753824
1.003406
[illegible]000000

DEPTH
14.0
RD=
.000315
E00=
.001900
E01=
.001370
E02=
.001380
RAW SIG =
.005810
.040580
.055220
.076560
.102820
.000314
NET SIG=
.005495
.040265
.054905
.076245
.102505
-.000001
CORR SIG=
.007629
.055959
.076384
.106183
.142902
-.000001
MICRO-WATTS CM-2
2.273370
7.207461
8.822359
11.000531
18.034251
-.013865
LOG MICRO-WATTS
.356670
.857782
.945585
1.041414
1 256098
[illegible]000000

DEPTH-
10.5
RD=
.000315
E00=
.001900
E01=
.001260
E02=
.001240
RAW SIG =
.015000
.077800
.100400
.132100
.168200
.000315
NET SIG=
.014685
.077485
.100085
.131785
.167885
0.000000
CORR SIG=
.022094
.116312
.149894
.196919
.250287
0.000000
MICRO-WATTS CM-2
6.583948
14.980990
17.312771
20.400822
31.586189
0.000000
LOG MICRO-WATTS
.818486
1.175541
1.238367
1.309648
1.499497
[illegible]000000

Sta. 15, Dn/W

DEPTH=
7.5

RD=
.000315

E00=
.001900

E01=
.001120

E02=
.001120

RAW SIG =
.034460
.131500
.162100
.206600
.247500
.000312

NET SIG=
.034145
.131185
.161785
.206285
.247185
-.000003

CORR SIG=
.057925
.222546
.274457
.349948
.419332
-.000005

MICRO-WATTS CM-2
17.261517
28.663923
31.699748
36.254589
52.919660
-.050852

LOG MICRO-WATTS
1.237079
1.457336
1.501056
1.559363
1.723617

DEPTH=
4.0

RD=
.000315

E00=
.001900

E01=
.001270

E02=
.001350

RAW SIG =
.123600
.340200
.400600
.116600
.533700
.002160

NET SIG=
.123285
.339885
.400285
.116285
.533385
.001845

CORR SIG=
.186104
.517650
.615035
.180238
.833918
.002780

MICRO-WATTS CM-2
55.458860
66.673344
71.036509
18.672664
105.240447
27.782307

LOG MICRO-WATTS
1.743971
1.823952
1.851482
1.271206
2.022183
[illegible]

DEPTH=
1.0

RD=
.000315

E00=
.001900

E01=
.001290

E02=
.001370

RAW SIG =
.254200
.567200
.652700
.801700
.878000
.007040

NET SIG=
.253885
.566885
.652385
.801385
.877685
.006725

CORR SIG=
.377255
.849756
.986441
1.222204
1.350035
.010397

MICRO-WATTS CM-2
112.422086
109.448557
113.933928
126.620370
170.374379
103.889845

LOG MICRO-WATTS
2.050852
2.039210
2.056653
2.102504
[illegible]14
[illegible]3

Sta. 15, Up/W

DEPTH=
1.0

FD=
.000315

E00=
.001900

E01=
.001380

E02=
.001440

RAW SIG =
.026550
.085740
.107100
.140600
.164500
000312

NET SIG=
.026235
.085425
.106785
.140285
.16[illegible]
-.000003

CORR SIG=
.036345
.119077
.149765
.197949
.233079
-.000004

MICRO-WATTS CM-2
.854113
1.362237
1.545576
1.737996
2.498608
-.002497

LOG MICRO-WATTS
-.068485
.134253
.189090
.240049
.397698
0.000000

Sta. 15, Up/W

DEPTH=
14.0
RD=
.000315
E00=
.001900
E01=
.001370
E02=
.001320
RAW SIG =
.000314
.007040
.010680
.016800
.026550
.000313
NET SIG=
-.000001
.006725
.010365
.016485
.026235
-.000002
CORR SIG=
-.000001
.009229
.014150
.022385
.035435
-.000003
MICRO-WATTS CM-2
-.000032
.105583
.146025
.196541
.379862
-.001666
LOG MICRO-WATTS
0.000000
-.976406
-.835571
-.706546
-.420374
0.000000

DEPTH=
7.5
RD=
.000315
E00=
.001900
E01=
.001110
E02=
.001130
RAW SIG =
.003366
.021060
.029000
.042100
.055830
.000314
NET SIG=
.003051
.020745
.028685
.041785
.055515
-.000001
CORR SIG=
.005236
.035692
.049480
.072261
.096250
-.000002
MICRO-WATTS CM-2
.123043
.408322
.510633
.634452
1.031799
-.001029
LOG MICRO-WATTS
-.909942
-.388998
-.291891
-.197601
.013595
0.000000

DEPTH=
4.0
RD=
.000315
E00=
.001900
E01=
.001370
E02=
.001290
RAW SIG =
.013130
.054600
.069850
.093060
.113200
.000314
NET SIG=
.012815
.054285
.069535
.092745
.112885
-.000001
CORR SIG=
.017624
.074028
.094020
.124328
.150019
-.000001
MICRO-WATTS CM-2
.414169
.846885
.970282
1.091602
1.608207
-.000829
LOG MICRO-WATTS
-.382822
-.072175
-.013102
.038064
.206342
0.000000

NOAACZCS 80-01

[illegible] NO.=
15

UP[illegible]

DEPTH=
2.0

RD=
.000315

E00=
.001900

E01=
.002240

E02=
.002160

RAW SIG =
.045460
.140600
.170600
.226100
.265200
.000928

NET SIG=
.045145
.140285
.170285
.225785
.264885
.000613

CORR SIG=
.038097
.117776
.142225
.187602
.218942
.000516

MICRO-WATTS CM-2
.895281
1.347361
1.467764
1.647143
2.347057
.309922

LOG MICRO-WATTS
-.048041
.129484
.166656
.216731
.370524
-.508748

DEPTH=
20.0

RD=
.000315

E00=
.001900

E01=
.001440

E02=
.001440

RAW SIG =
.000321
.002754
.004600
.008250
.015560
.000314

NET SIG=
.000006
.00243[illegible]
.004285
.007935
.015245
-.000001

CORR SIG=
.000008
.003218
.005654
.010470
.020115
-.000001

MICRO-WATTS CM-2
.000186
.036815
.058347
.091925
.215632
-.000793

LOG MICRO-WATTS
-3.730390
-1.433971
-1.233978
-1.036367
-.666287
0.000000

DEPTH=
17.0

RD=
.000315

E00=
.001900

E01=
.001430

E02=
.001390

RAW SIG =
.000313
.003984
.006425
.010680
.018620
.000313

NET SIG=
-.000002
.00[illegible]
.00611[illegible]
.010365
.018305
-.000002

CORR SIG=
-.000003
.004836
.008021
.013551
.023035
-.000003

MICRO-WATTS CM-2
-.000062
.055323
.082774
.118981
.255310
-.001596

LOG MICRO-WATTS
0.000000
-1.257097
-1.082105
-.924524
-.592592
0.000000

Sta. 40, Dn/W

```
DEPTH=
            1.0
RD=
            .000289
E00=
            .000010
E01=
            .000120
E02=
            .000150
RAW SIG =
         1.284000
         1.859000
          .000288
         2.249000
          .000289
          .051500
NET SIG=
         1.283711
         1.858711
         -.000001
         2.248711
         0.000000
          .051211
CORR SIG=
         1.266990
         1.835469
         -.000001
         2.222936
         0.000000
          .050937
MICRO-WATTS CM-2
      1506.450938
      1486.729743
         -.000733
      1344.876275
         0.000000
      1026.379635
LOG MICRO-WATTS
         3.177955
         3.172232
         0.000000
         3.128682
         0.000000
          011308
```

```
DEP
            94.0
RD=
            .000289
E00=
            .000010
E01=
            .000600
E02=
            .000630
RAW SIG =
          .008840
          .028400
          .022200
          .005170
          .001520
          .000288
NET SIG=
          .008551
          .028111
          .021911
          .004881
          .001231
         -.000001
CORR SIG=
          .007884
          .025898
          .020170
          .004489
          .001131
         -.000001
MICRO-WATTS CM-2
         9.374620
        20.977708
        14.965952
         2.716087
          .744057
         -.018594
LOG MICRO-WATTS
          .971954
         1.321758
         1.175104
          .432944
         -.128394
      [illegible]00000
```

```
DEPT
            52.0
RD=
            .000206
E00=
            .000010
E01=
            .000890
E02=
            .000980
RAW SIG =
          .069200
          .157800
          .139400
          .066200
          .031400
          .000288
NET SIG=
          .068914
          .157514
          .139114
          .065914
          .031114
          .000002
CORR SIG=
          .062182
          .142333
          .125888
          .059733
          .028237
          .000002
MICRO-WATTS CM-2
        73.934704
       115.289716
        93.408757
        36.138610
        18.571490
          .036335
LOG MICRO-WATTS
         1.868848
         2.061791
         1.970388
         1.557971
         1.268847
      [illegible]39674
```

Best Available Copy C-10

Sta. 40, Dn/W

DEPTH=	48.0	44.0	40.0
RD=	.000286	.000286	.000286
E00=	.008010	.008010	.008010
E01=	.009080	.009980	.009280
E02=	.008980	.009190	.009190
RAW SIG =	.077100	.080100	.111300
	.178500	.196800	.246300
	.163300	.184600	.233400
	.084500	.102800	.140000
	.044200	.056400	.081400
	.000288	.000286	.000286
NET SIG=	.076814	.0[illegible]7814	.11101[illegible]
	.178214	.1[illegible]514	.24601[illegible]
	.163014	.1[illegible]314	.23311[illegible]
	.08421[illegible]	.102514	.139714
	.0439[illegible]	.056114	.081114
	.000002	0.000000	0.000000
CORR SIG=	.067655	.078590	.095638
	.156718	.176459	.211757
	.143125	.166054	.200374
	.073822	.092664	.119925
	.038434	.050890	.069528
	.000002	0.000000	0.000000
MICRO-WATTS CM-2	80.442285	93.444059	113.773580
	126.941438	142.932066	171.523291
	106.198582	123.212188	148.677799
	44.662376	56.061604	72.554428
	25.278083	37.470006	45.728420
	.035518	0.000000	0.000000
LOG MICRO-WATTS	1.905484	1.970552	2.056041
	2.103603	2.155130	2.234323
	2.026119	2.[illegible]90554	2.172246
	1.649942	[illegible]8666	1.860664
	1.402744	[illegible]57	1.660186
	449551	[illegible]000000	[illegible]00000

Sta. 40, Dn/W

[illegible]

RD=
.0[illegible]0286
E00=
008010
E01=
00[illegible]260
E02=
.00[illegible]330

RAW SIG =
.135700
.29[illegible]200
.277000
.174900
.111900
00028[illegible]

NET SIG=
.135414
[illegible]
.275[illegible]14
.17[illegible]14
.1[illegible]614
0.000A0E

CORR SIG=
.1172[illegible]
.1539[illegible]
.2389[illegible]2
.151596
.097069
0.000000

MICRO-WATTS CM-2
139.423560
205.676467
177.260048
91.776142
63.842380
0.000000

LOG MICRO-WATTS
2.144335
2.313105
2.248660
1.962730
1.805109
0.000000

32.0

RD=
.000286
E00=
.008010
E01=
.009220
E02=
.009260

RAW SIG =
.157200
.330400
.322500
.219400
.141800
.000289

NET SIG=
.156914
.330[illegible]
.322214
.219114
.141514
.000003

CORR SIG=
.136406
.287147
.280449
.190631
.123324
.00000[illegible]

MICRO-WATTS CM-2
162.186422
232.588955
238.092991
115.452540
81.109910
.052567

LOG MICRO-WATTS
2.210014
2.366589
2.318257
2.062403
1.909074
-1.279289

[illegible]
[illegible]7.5

RD=
.000286
E00=
[illegible]0[illegible]010
E01=
.009190
E02=
.009230

RAW SIG =
.178500
.362700
.358500
.266400
.190000
.000287

NET SIG=
.17[illegible]
.362414
.35[illegible]
.266114
.189714
.00000[illegible]

CORR SIG=
.155428
.316273
.312802
.232522
.165869
.000001

MICRO-WATTS CM-2
184.803803
256.181213
232.099200
140.675998
109.092197
.017583

LOG MICRO-WATTS
2.266711
2.408547
2.365674
2.148220
2.037794
-1 754905

Sta. 40, Dn/W

DEPTH	24.0	20.0	16.5
RD=	.000286	.000286	.000288
E00=	.008010	.008010	.008010
E01=	.009430	.009410	.009580
E02=	.009380	.009310	.009836
RAW SIG =	.211500	.2297	.249300
	.400000	.46650	.443900
	.365200	.514100	.460400
	.340600	.426800	.397500
	.221600	.337100	.311500
	.000288	.000289	.000288
NET SIG=	.211214	.229414	.249012
	.399714	.466214	.443612
	.364914	.513814	.460112
	.340514	.426514	.397212
	.231314	.336814	.311212
	.000002	.000003	0.000000
CORR SIG=	.179273	.194986	.208980
	.339009	.395646	.373680
	.309259	.435376	.389014
	.288361	.360851	.337073
	.195737	.284525	.265065
	.000002	.000003	0.000000
MICRO-WATTS CM-2	213.155216	231.837766	248.477342
	274.597211	320.472857	302.680622
	229.470181	323.048899	288.648610
	174.458450	218.315003	203.929248
	128.736295	187.132134	174.333106
	.034170	.051223	0.000000
LOG MICRO-WATTS	2.328696	2.365184	2.395287
	2.438696	2.505791	2.480985
	2.360726	2.509268	2.460369
	2.241692	2.339084	2.309480
	2.109701	2.272148	2.241380
	[illegible].466359	-1.290534	0.000000

Sta. 40, Dn/W

DEPTH[illegible]
12.0
[illegible]
.000288
E00=
.008010
E01=
.009430
E02=
.009750
RAW SIG =
.324900
.561800
.699600
.656400
.588000
.000288
NET SIG=
.324612
.66[illegible]
.699312
.6561[illegible]
.58771[illegible]
0.00[illegible]
CORR SIG=
.277[illegible]
.567352
.602655
.568130
.511325
0.000000
MICRO-WATTS CM-2
329.434902
459.555703
447.169837
343.718759
336.298325
0.000000
LOG MICRO-WATTS
2.517770
2.662338
2.650473
2.536203
2.526725
[illegible].000000

DEPTH
8.0
RD=
.000288
E00=
.008010
E01=
.009650
E02=
.009960
RAW SIG =
.292000
.530600
.579400
.843100
.691700
.000288
NET SIG=
.291712
.530312
.579112
.84281[illegible]
.691412
0.000000
CORR SIG=
.243248
.444231
.487318
.712432
.587090
0.000000
MICRO-WATTS CM-2
289.222342
359.826850
361.589631
431.021637
386.128976
0.000000
LOG MICRO-WATTS
2.461232
2.556094
2.558216
2.634499
2.586732
[illegible]000000

DEPTH=
[illegible].0
RD=
.000288
E00=
.008010
E01=
.009960
E02=
.009750
RAW SIG =
.494600
.887100
.964500
1.214000
1.319000
.008220
NET SIG=
.49[illegible]
.8868[illegible]
.964[illegible]
1.21[illegible]
1.3187[illegible]
.00[illegible]
CORR SIG=
.39[illegible]35
.708[illegible]9
.768422
.964316
1.044543
.006216
MICRO-WATTS CM-2
471.242861
574.199727
570.168827
583.411065
686.995680
125.248498
LOG MICRO-WATTS
2.673245
2.759063
2.756003
2.765975
2.836[illegible]54
[illegible]097[illegible]73

6

Sta. 40, Dn/W

DEPTH
[illegible]

RD=
[illegible]
E00=
.06[illegible]
E01=
.00[illegible]630
E02=
.009830

RAW SIG =
.57[illegible]00
1.15[illegible]00
1.[illegible]00
1.4[illegible]00
1.465[illegible]00
.01000[illegible]

NET SIG=
.573011
1.158711
1.[illegible]711
1.4[illegible]12
1.4647[illegible]
.009[illegible]

CORR SIG=
.475[illegible]06
.963060
1.039319
1.230275
1.225448
.008220

MICRO-WATTS CM-2
565.020263
780.078205
771.174985
744.316458
805.976844
165.633080

LOG MICRO-WATTS
2.752064
2.892138
2.887153
2.871758
2.906323
2.219147

ROI [illegible]0-01

[illegible]
.0

UP/[illegible]

DEPTH
0.0

RD=
.000288
E00=
.000010
E01=
.000020
E02=
.000010

RAW SIG =
[illegible].22[illegible]00
1.889[illegible]00
.000293
[illegible].511000
.000[illegible]92
.086[illegible]70

NET SIG=
[illegible]
1.88[illegible]
.50[illegible]05
.[illegible]10[illegible]
.000004
.086602

CORR SIG=
1.219971
1.885684
.000005
2.505793
.000004
.086283

MICRO-WATTS CM-2
[illegible].636861
[illegible].931746
.000130
5[illegible].986135
.000110
6[illegible].402599

LOG MICRO-WATTS
.598099
[illegible].715433
[illegible].886330
.770013
[illegible]57[illegible]1
[illegible]812[illegible]1

DEPTH
1.0

RD=
.000288
E00=
.000010
E01=
.000150
E02=
.000260

RAW SIG =
.010000
.019900
.019200
.015500
.013100
.000[illegible]

NET SIG=
.009[illegible]1[illegible]
.019[illegible]1[illegible]
.01891[illegible]
.01521[illegible]
.0128[illegible]
0.000000

CORR SIG=
.009564
.019251
.018695
.015066
.012713
0.000000

MICRO-WATTS CM-2
.310721
.530169
.496624
.354054
.351399
0.000000

LOG MICRO-WATTS
-.507629
-.275586
-.312806
[illegible].450931
[illegible]454199
[illegible]0000

DEPT
94.0

RD=
.000288
E00=
.00[illegible]010
E01=
.008770
E02=
.008740

RAW SIG =
.000286
.000287
.000285
.000287
.00028[illegible]
0.000000

NET SIG=
-.000002
-.00000[illegible]
-.00000[illegible]
-.00000[illegible]
-.00000
-.00028

CORR SIG=
-.000002
-.000001
-.000003
-.000001
-.000002
-.000263

MICRO-WATTS CM-2
-.000059
-.000025
-.000071
-.000021
-.000050
-.184235

LOG MICRO-WATTS
0.000000
0.000000
0.000000
0.000000
0.000000
[illegible]0000

Sta. 40, Up/W

DEP... / DEPTH–	52.0	44.0	27.5
RD=	.000286	.000286	.000286
E00=	.008010	.008010	.008010
E01=	.008860	.009170	.009370
E02=	.009000	.009180	.009330
RAW SIG =	.000900	.000900	.003340
	.002100	.003340	.008220
	.002100	.002730	.007010
	.000900	.001520	.003960
	.000287	.000287	.002130
	.000287	.000288	.000288
NET SIG=	.000614	.000614	.003054
	.001814	.003054	.00793[illegible]
	.001814	.002444	.00672[illegible]
	.000614	.00123[illegible]	.00367[illegible]
	.000001	.000001	.00184[illegible]
	.000001	.000002	.000002
CORR SIG=	.000556	.000536	.002609
	.001647	.002669	.006774
	.001651	.002136	.005738
	.000560	.001079	.003133
	.000001	.000001	.001572
	.000001	.000002	.000002
MICRO-WATTS CM-2	.018076	.017428	.084771
	.045369	.073491	.186560
	.042978	.055596	.149348
	.013163	.025346	.073627
	.000025	.000024	.043437
	.000633	.001224	.001197
LOG MICRO-WATTS	-1.742903	-1.758751	-1.071754
	-1.343242	-1.133768	-.729182
	-1.366756	-1.254958	-.825801
	-1.880657	-1.596083	-1.132962
	-4.597384	-4.616860	-1.362136
	[illegible]8451	[illegible]12360	[illegible]21738

Sta. 40, Up/W

DEPTH-	20.0	[illegible].0	1[illegible]
RD=	.000286	.000286	.00028
E00=	.008010	.008010	.00801
E01=	.009440	.009750	.00[illegible]79
E02=	.009460	.009450	.00983
RAW SIG =	.004570	.007610	.00946
	.011300	.015500	.01860
	.009460	.013100	.01740
	.005170	.008220	.01250
	.003340	.005170	.01000
	.000288	.000292	.00029
NET SIG=	.004284	.007324	.00917
	.011014	.015214	.0183
	.009174	.012814	.0171
	.004884	.007934	.0122
	.003054	.004884	.00971
	.000002	.000006	.00006
CORR SIG=	.003636	.005990	.00750
	.009351	.012389	.01500
	.007791	.010388	.01402
	.004149	.006403	.01001
	.002595	.003924	.00796
	.000002	.000005	.00000
MICRO-WATTS CM-2	.118138	.194630	.24395
	.257533	.341190	.41310
	.202809	.270406	.36507
	.097506	.150479	.23535
	.071734	.108463	.22027
	.001189	.003452	.00229
LOG MICRO-WATTS	-.927609	-.710789	-.61268
	-.599167	-.467003	-.38394
	-.692912	-.567984	-.43761
	-1.010970	-.822524	-.62828
	-1.144275	-.964720	-.65703
	[illegible]92[illegible]959	[illegible]61981	[illegible]3972

HOAAL : > .0-01

STA

+3

DN/W

DEPTH=	0.0	1.0	27.0
RD=	.000293	.000293	.000293
E00=	.008768	.008768	.008768
E01=	.008724	.008685	.008863
E02=	.008768	.008828	.008843
RAW SIG =	.191700	1.169000	.039950
	1.832000	1.799000	.141200
	2.144000	1.923000	.157800
	2.616000	2.165000	.130900
	3.015000	2.316000	.110100
	.094903	.046500	.000292
NET SIG=	.191407	1.168707	.039657
	1.831707	1.798707	.140907
	2.143707	1.922707	.157507
	2.615707	2.164707	.130607
	3.014707	2.315707	.109807
	.094607	.046207	-.000001
CORR SIG=	.192511	1.182654	.039219
	1.843601	1.824448	.139307
	2.159181	1.954793	.155668
	2.636484	2.205977	.129040
	3.040838	2.365360	.108455
	.096339	.048311	-.000001
MICRO-WATTS CM-2	228.895718	1406.175643	46.631710
	1493.316653	1477.802753	112.838422
	1602.112015	1450.456176	115.505570
	1595.072591	1334.615894	78.069373
	1999.959250	1555.697240	71.330683
	1941.221798	973.471651	-.019928
LOG MICRO-WATTS	2.359638	3.148040	1.668681
	3.174152	3.169616	2.052457
	3.204693	3.161505	2.062603
	3.202780	3.125356	1.892481
	3.301021	3.191925	[illegible]3276
	[illegible]	[illegible]88323	[illegible]00000

Sta. 43, Dn/W

DE[illegible]	[illegible].5	21.0	18.0
RD=	.000293	.000293	.000293
E00=	.008768	.008768	[illegible]08768
E01=	.009070	.009140	.009260
E02=	.006370	.009120	.009170
RAW SIG =	.058260	.075920	.107700
	.186500	.221800	.292000
	.205400	.244400	.323100
	.177900	.221200	.305400
	.130300	.198100	.280000
	.000293	.000291	.000294
NET SIG=	.0579[illegible]	.07562[illegible]	.1074[illegible]
	.186207	.22150[illegible]	.2917[illegible]
	.205107	.24410[illegible]	.3229[illegible]
	.17760[illegible]	.220907	.3051[illegible]
	.130007	.19780[illegible]	.2797[illegible]
	0.000000	-.00000[illegible]	.00000[illegible]
CORR SIG=	.053651	.072526	.101559
	.164682	.212359	.275440
	.172956	.233952	.304381
	.142458	.211651	.287290
	.098928	.189459	.263005
	0.000000	-.000002	.000001
MICRO-WATTS CM-2	63.791595	86.233727	120.753568
	133.392052	172.010494	223.1066[illegible]1
	128.333538	173.592360	225.850890
	86.187156	128.048730	173.810476
	65.065136	124.607400	172.978520
	0.000000	-.038641	.019023
LOG MICRO-WATTS	1.804763	1.935677	2.081900
	2.125130	2.235555	2.34851[illegible]
	2.108340	2.239531	2.353822
	1.935443	2.107375	2.240076
	1.813348	2.095544	2.237992
	0.000000	0.000000	[illegible]20725

Sta. 43, Dn/W

DEPTH=	1..0	2.0	[illegible].0
RD=	.000299	.000299	.000299
E00=	.008768	.008768	.008768
E01=	.009170	.009360	.009340
E02=	.009220	.009270	.009534
RAW SIG =	.043870	.217000	.309100
	.360900	.494000	.650300
	.400000	.548300	.730200
	.402400	.573300	.802300
	.384700	.566600	.823000
	.000291	.000293	.000908
NET SIG=	.043571	.216701	.308801
	.360601	.493701	.65000
	.399701	.548001	.72990
	.402101	.573001	.80200
	.384401	.566301	.82270
	-.000008	-.000006	.00060
CORR SIG=	.041693	.202716	.298750
	.345330	.461204	.613818
	.383073	.511224	.691306
	.385673	.533808	.761830
	.368982	.526837	.783787
	-.000008	-.000006	.000581
MICRO-WATTS CM-2	49.573443	241.029332	345.702295
	279.717654	373.574964	497.192982
	284.239859	379.327893	512.949085
	233.331908	322.953678	460.907066
	242.679671	346.500430	515.496703
	-.154471	-.112629	11.711729
LOG MICRO-WATTS	1.695249	2.382070	2.538702
	2.446720	2.572378	2.696525
	2.453685	2.579015	2.710074
	2.367974	2.509140	2.663613
	2.385033	2.539704	2.712226
	0.000000	0.000000	1.068621

Sta. 43, Dn/W

[illegible]
6.0

RD=
.000299
E00=
.008768
E01=
.009730
E02=
.009830

RAW SIG =
.461000
.904200
1.040000
1.154000
1.20600[illegible]
.00396

NET SIG=
.46070
.90390
1.03970
1.15370
1.20570
.00366

CORR SIG=
.41576[illegible]
.81692[illegible]7
.941037
1.045747
1.094478
.003344

MICRO-WATTS CM-2
494.340869
661.710861
698.2495[illegible]
63[illegible].676825
71[illegible].838164
67.[illegible]74083

LOG MICRO-WATTS
2.694027
2.820668
2.844011
2.801182
2.857235

3.0

RD=
.000299
E00=
.008768
E01=
.010060
E02=
.010340

RAW SIG =
.707000
1.131000
1.300000
1.556000
1.754000
.01555[illegible]

NET SIG=
.70670[illegible]
1.130701
1.299701
1.555701
1.753701
.0[illegible]7251

CORR SIG=
.618391
.993330
1.146307
1.377490
1.558892
.013868

MICRO-WATTS CM-2
735.267270
804.597643
850.559766
833.381355
1025.283097
279.437745

LOG MICRO-WATTS
2.866445
2.905579
[illegible].929705
2.920844
3.010844

DEPTH=
1.0

RD=
000299
E00=
.[illegible]08768
E01=
.010230
E02=
.009730

RAW SIG =
.759500
1.392000
1.589000
1.832000
1.966000
.046100

NET SIG=
.759[illegible]01
1.39170[illegible]
1.58870[illegible]
1.83170[illegible]
1.9[illegible]5701
.045801

CORR SIG=
.646153
1.176135
1.333104
1.526037
1.625900
.035741

MICRO-WATTS CM-2
768.276386
952.669481
989.163274
923.252190
1069.354538
720.182375

LOG MICRO-WATTS
2.885517
2.978942
[illegible].995268
[illegible]
[illegible]
[illegible]

NORACZCS 80-01

[illegible]

4.0

UP.W

DEPTH=
1.0

RD=
.000293

E00=
.008768

E01=
.008[illegible]

E02=
.00866[illegible]

RAW SIG =
.01424[illegible]
.04000[illegible]
.045[illegible]
.044[illegible]
.043[illegible]
.000[illegible]

NET SIG=
[illegible]
.03970[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

CORR SIG=
.014[illegible]
.040746
.046357
.045809
.044640
.000005

MICRO-WATTS CM-2
.467633
1.122156
1.206674
1.076507
1.233857
.003585

LOG MICRO-WATTS
-.330095
.050053
.081590
.032017
.091[illegible]
-2.445561

DEPTH=
27.0

RD=
.000293

E00=
.008768

E01=
.008910

E02=
.008950

RAW SIG =
.000908
.006400
.008230
.001530
.005790
.000293

NET SIG=
.000615
.006107
.007937
.001237
.005497
0.000000

CORR SIG=
.000606
.006017
.007826
.001220
.005427
0.000000

MICRO-WATTS CM-2
.019676
.165719
.203699
.028680
.149996
0.000000

LOG MICRO-WATTS
-1.706074
-.780628
-.691011
-1.542426
-.823922
0.000000

DEPTH=
24.5

RD=
.000293

E00=
.008768

E01=
.009260

E02=
.009090

RAW SIG =
.000908
.007020
.008850
.007620
.006410
.000293

NET SIG=
.00061[illegible]
.00672
.00855
.00732
.00611
0.00000[illegible]

CORR SIG=
.000581
.006336
.008039
.006865
.005716
0.000000

MICRO-WATTS CM-2
.018870
.174497
.209243
.161324
.157989
0.000000

LOG MICRO-WATTS
-1.724227
-.758214
-.679349
-.792301
-.801372
0.000000

Sta. 43, Up/W

[illegible]
21.0

RD=
.000293

E00=
.008768

E01=
.009120

E02=
.009220

RAW SIG =
.000906
.007610
.009460
.007610
.006400
.000291

NET SIG=
.000613
.007317
.009157
.007317
.006107
-.000001

CORR SIG=
.000590
.007057
.008855
.007079
.005917
-.000002

MICRO-WATTS CM-2
.019178
.194340
.230486
.166350
.163555
-.001347

LOG MICRO-WATTS
-1.717204
-.711438
-.637355
-.778978
-.786337
0.000000

DEPTH=
18.0

RD=
.000293

E00=
.008768

E01=
.009190

E02=
.009220

RAW SIG =
.001520
.009460
.011300
.009460
.007610
.000293

NET SIG=
.001227
.009167
.011007
.009167
.00731[illegible]
0.0000[illegible]

CORR SIG=
.001171
.008754
.010516
.008762
.006997
0.000000

MICRO-WATTS CM-2
.038052
.241091
.273739
.205916
.193405
0.000000

LOG MICRO-WATTS
-1.419618
-.617919
-.562664
-.686310
-.71[illegible]531
0.000000

DEPTH=
15.0

RD=
.000293

E00=
.008768

E01=
.009240

E02=
.009210

RAW SIG =
.002730
.012500
.014300
.012500
.010100
.000294

NET SIG=
.0024[illegible]
.0122[illegible]
.01400[illegible]
.01220[illegible]
.009807
.000001

CORR SIG=
.002311
.011573
.013273
.011562
.009284
.000001

MICRO-WATTS CM-2
.075099
.318712
.345496
.271705
.256622
.000665

LOG MICRO-WATTS
-1.124368
-.496602
-.461557
-.565902
-.5[illegible]707

Sta. 43, Up/W

DEPTH= 12.0

RD= .000293
E00= .008768
E01= .009810
E02= .009470

RAW SIG =
.003970
.016800
.019200
.016800
.014900
.0002

NET SIG=
.0036[illegible]7
.016507
.018907
.016507
.014607
.000001

CORR SIG=
.003471
.015622
.017938
.015699
.013926
.000001

MICRO-WATTS CM-2
.112787
.430242
.466915
.368923
.384905
.000660

LOG MICRO-WATTS
-.947740
-.366288
-.330762
-.433065
-.41[illegible]46

DEPTH= 9.0

RD= .000293
E00= .008768
E01= .009450
E02= .009580

RAW SIG =
.005790
.021700
.024700
.022900
.020400
.000294

NET SIG=
.00549[illegible]
.02140[illegible]
.02440[illegible]
.02260[illegible]
.02010[illegible]
.000001

CORR SIG=
.005110
.019940
.022779
.021141
.018839
.000001

MICRO-WATTS CM-2
.166034
.549154
.592943
.496802
.520721
.000650

LOG MICRO-WATTS
-.779802
-.260306
-.226987
-.303816
[illegible]

DEPTH= 6.0

RD= .000293
E00= .008768
E01= .009730
E02= .009760

RAW SIG =
.008230
.027700
.030300
.028400
.0253[illegible]
.00029[illegible]

NET SIG=
.0079[illegible]
.02740[illegible]
.03050[illegible]
.02810[illegible]
.025007
.000002

CORR SIG=
.007155
.024719
.027527
.025373
.022584
.000002

MICRO-WATTS CM-2
.232480
.680763
.716532
.596260
.624229
.001262

LOG MICRO-WATTS
-.633615
-.167004
-.144765
-.224565
[illegible]

Sta. 43, Up/w1

DEPTH=		DEPTH=	
	3.0		1.0
RD=	.000293	RD=	.000293
E00=	.008768	E00=	.008768
E01=	.009950	E01=	.009230
E02=	.010590	E02=	.009530
RAW SIG =	.010700	RAW SIG =	.012490
	[illegible]		.035100
	[illegible]		.036300
	[illegible]		.035100
	.035100		.033200
	[illegible]		.000294
NET SIG=	[illegible]	NET SIG=	.012197
	[illegible]		.034807
	[illegible]		.026007
	[illegible]		.034807
	[illegible]		.032907
	[illegible]		.000001
CORR SIG=	.009243	CORR SIG=	.011640
	.025160		.033372
	.030317		.034682
	.032733		.030679
	.031884		.031986
	.000001		[illegible]
MICRO-WATTS CM-2	.300312	MICRO-WATTS CM-2	.370195
	.692896		.919068
	.789150		.902763
	.769221		.791468
	.881234		.884102
	.000618		.000666
LOG MICRO-WATTS	-.522428	LOG MICRO-WATTS	-.422285
	-.159332		-.036652
	-.102840		-.044426
	-.113949		[illegible]

JAACZCS 80-01

STN NO. 47

DH W

DEPTH= 0.0	DEPTH= 1.0	DEPTH= 90.0
RD= [illegible]	RD= .000289	RD= .000285
E00= .002230	E00= .002230	E00= .002230
E01= .002020	E01= .004480	E01= .004570
E02= .002230	E02= .004860	E02= .004790
RAW SIG =	RAW SIG =	RAW SIG =
.190100	.341400	.000901
.313400	.551400	.005167
.346900	.615400	.004000
.422600	.732600	.001518
.469000	.811400	.000285
.011900	.016150	.000287
NET SIG=	NET SIG=	NET SIG=
[illegible]	[illegible]	.00061
[illegible]	[illegible]	.00488
[illegible]	[illegible]	.00371
[illegible]	.7320[illegible]1	.00123
[illegible]	.811111	0.000000
.0[illegible]1611	.015861	.000002
CORR SIG=	CORR SIG=	CORR SIG=
.212659	.171654	.000303
.355940	.280980	.002415
.399710	.317324	.001850
.493938	.382207	.000618
.555900	.428231	0.000000
.013381	.008386	.000001
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
252.851522	204.333934	.359858
288.311079	227.593946	1.956186
296.585114	235.454388	1.372869
298.832631	231.235023	.374028
365.615724	281.647553	0.000000
269.624015	168.967928	.019666
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
2.402866	2.310340	-.443869
2.459861	2.357161	.291410
2.472149	2.371907	.137629
2.475428	2.364054	-.427096
2.563025	2.449706	0.000000
2.430759	[illegible]7804	[illegible]36281

Sta. 47, Dn/W

DEPTH	DEPT	DEPTH
44.0	40.0	36.0
RD=	RD=	RD=
.000285	.000285	000291
E00=	E00=	E00=
.002230	.002230	.002230
E01=	E01=	E01=
.003910	.002620	.002540
E02=	E02=	E02=
.003250	.002430	.002910
RAW SIG =	RAW SIG =	RAW SIG =
.011890	.009457	.014330
.036290	.028360	.039940
.035060	.026360	[illegible]
.020420	.017980	.030190
.011690	.011280	.021040
.000287	.000299	[illegible]
NET SIG=	NET SIG=	NET SIG=
.011505	[illegible]	[illegible]
.036005	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
.020135	.017695	.02985
.011635	.010995	[illegible]
.000002	.000005	0.000000
CORR SIG=	CORR SIG=	CORR SIG=
.006459	.007726	.012582
.019543	.023400	.036260
.018397	.023152	.038720
.010375	.014436	.028428
.005820	.008273	.020114
.000001	.000004	0.000000
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
7.679686	9.185911	14.960390
15.830217	18.954231	29.370746
13.650645	17.179140	28.730491
6.276797	8.733941	17.198707
3.827744	5.835837	13.228958
.022906	.085643	0.000000
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
.885343	.963122	1.174943
1.199487	1.277706	1.467915
1.135153	1.235001	1.458343
.797738	.941210	1.235496
582943	[illegible]	[illegible]
540045	067303	[illegible]

Sta. 47, Dn/W

DEPTH= 32.0	DEPTH= 23.5	DEPTH= 24.0
RD= .000291	RD= .002230	RD= .000294
E00= .002230	E00= .002230	E00= .002230
E01= .003600	E01= .003150	E01= .002270
E02= .003980	E02= .002820	E02= .002110
RAW SIG =	RAW SIG =	RAW SIG =
.025920	.028360	.026540
.069830	.068600	.062520
.074100	.071040	.064340
.057020	.055200	.053370
.041170	.040000	.041180
.000292	.000292	.000294
NET SIG=	NET SIG=	NET SIG=
.02562	.02613	.026246
.06953	.06637	.062226
.07380[illegible]	.06881[illegible]	.064046
.05672[illegible]	.0529[illegible]	.053076
.04057[illegible]	.037[illegible]	.040886
.000001	-.001938	0.000000
CORR SIG=	CORR SIG=	CORR SIG=
.016115	.018221	.025524
.044376	.045578	.059897
.047791	.046524	.061015
.037262	.035252	.050039
.027233	.024736	.038141
.000001	-.001364	0.000000
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
19.161183	21.665075	30.347603
35.944520	36.918151	48.516750
35.460889	34.520663	45.273090
22.543611	21.327636	30.273336
17.911405	16.268802	25.685559
.012557	-27.492005	0.000000
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
1.282422	1.335760	1.482124
1.555633	1.567240	1.685892
1.549750	1.538079	1.655840
1.353023	1.328943	1.481060
1.[illegible]	1.211356	1.[illegible]9424
	[illegible]00	[illegible]00

Sta. 47, Dn/W

DEPTH	[illegible].0	[illegible]	.0
RD=	.000294	.000294	.000294
E00=	.002230	.002230	.002230
E01=	.001810	.001750	.001630
E02=	.001760	.001780	.001700
RAW SIG =	.027150	.033850	.041770
	.060100	.071040	.083900
	.063100	.075930	.090600
	.057030	.072230	.091830
	.046650	.064340	.086340
	.000296	.000296	.000295
NET SIG=	.027456	.033556	.041476
	.059806	.070746	.083602
	.062806	.075636	.0903[illegible]
	.056736	.071986	.0915[illegible]
	.04[illegible]36	.064046	.0860[illegible]
	.000002	.000002	.000001
CORR SIG=	.033693	.042865	.057092
	.073101	.090593	.115786
	.076463	.097091	.125824
	.068797	.092630	.128306
	.055[illegible]25	.082613	.121334
	.000002	.000003	.000001
MICRO-WATTS CM-2	40.061428	50.966193	67.882038
	59.212210	73.380016	93.786716
	56.735363	72.041295	93.361131
	41.622029	56.041281	77.625397
	36.821063	54.334730	79.801378
	.049574	.051417	.027676
LOG MICRO-WATTS	1.602726	1.707282	1.831755
	1.772411	1.865579	1.972141
	1.753854	1.857582	1.970166
	1.619323	1.748508	1.890004
	1.566[illegible]	1.735078	1.902010
	-1.[illegible]04[illegible]	[illegible]	[illegible]

Sta. 47, Dn/W

DEPT	8.0	DEP	1.0
RD=	.000294	RD=	.000297
E00=	.002230	E00=	.002230
E01=	.001560	E01=	.002160
E02=	.001490	E02=	.002280
RAW SIG =	.052760	RAW SIG =	.146700
	.099150		.249300
	.105200		.276200
	.113800		.331700
	.113800		.362200
	.000297		.007020
NET SIG=	[illegible]	NET SIG=	[illegible]
	[illegible]		[illegible]
	[illegible]		[illegible]
	.113506		[illegible]
	.113506		[illegible]
	.000003		[illegible]
CORR SIG=	.074518	CORR SIG=	.152348
	.139500		.261157
	.147075		.291633
	.158091		.353015
	.157050		.388473
	.000004		.007069
MICRO-WATTS CM-2	88.602173	MICRO-WATTS CM-2	181.142158
	112.994889		211.537282
	109.129663		216.391753
	95.644944		213.574349
	103.291574		255.498564
	.085972		142.433607
LOG MICRO-WATTS	1.947444	LOG MICRO-WATTS	2.258020
	2.053059		2.325387
	2.037943		2.335241
	1.980662		2.329549
	2.014065		2.407388
	165641		53612

ACZCS 80-0

SIG NO.= 47

UP. H

DEPTH= 1.0	DEP[illegible] [illegible]0.0	DEF 44.0
PD= .000285	PD= .000285	RD= 000285
E00= .002230	E00= .002230	E00= .0[illegible]2230
E01= .005130	E01= .004690	E01= .003020
E02= .005370	E02= .004430	E02= .002740
RAW SIG =	RAW SIG =	RAW SIG =
.004570	.000287	.000288
.010700	.000287	.000904
.011300	.000288	.000288
.010000	.000287	.000289
.008840	.000287	.000289
.002850	.000288	.000289
[illegible] SIG=	NET SIG=	NET SIG=
.004285	.000002	.000003
.010415	.00000[illegible]	.000[illegible]
.011015	.0000[illegible]	.0000[illegible]
.009715	.00000[illegible]	.00[illegible]
008555	.000[illegible]	.000[illegible]
.002565	.00000[illegible]	.0000[illegible]
CORR SIG=	CORR SIG=	CORR SIG=
.001875	.000001	.000002
.004588	.000001	.000445
.004884	.000001	.000002
.004336	.000001	.000003
.003843	.000001	.000003
.001116	.000001	.000003
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.060923	.000031	.000071
.126352	.000026	.012254
.127138	.000036	.000055
.101898	.000022	.000066
.106227	.000025	.000076
.781301	.000999	.002069
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-1.215216	-4.513545	-4.148628
-.898417	-4.588815	-1.911719
-.895724	-4.440726	-4.256734
-.991633	-4.664765	-4.182239
-.973765	-4.597865	-4.117893
[illegible]07182	[illegible]401	[illegible]94296

Sta. 47, Up/w

1.0

RD=
.000291
E00=
.002230
E01=
.002390
E02=
.002400

RAW SIG =
.000290
.000910
.000290
.000290
.000290
.000290

NET SIG=
-.000001
.000619
-.000001
-.000001
-.000001
.000001

CORR SIG=
-.000001
.000578
-.000001
-.000001
-.000001
-.000001

MICRO-WATTS CM-2
-.000030
.015925
-.000024
-.000022
-.000026
-.000654

LOG MICRO-WATTS
0.000000
-1.797919
0.000000
0.000000
0.000000
0.000000

[illegible]

RD=
.000291
E00=
.002230
E01=
.003190
E02=
.003300

RAW SIG =
.000292
.001522
.001523
.000906
.000907
.000292

NET SIG=
.000001
.001231
.001232
.000615
.000616
.000001

CORR SIG=
.000001
.000869
.000874
.000438
.000441
.000001

MICRO-WATTS CM-2
.000023
.023933
.022750
.010302
.012196
.000490

LOG MICRO-WATTS
-4.641600
-1.621002
-1.643023
-1.987060
-1.913789
-3.310130

[illegible]3

RD=
.000291
E00=
.002230
E01=
.004030
E02=
.003790

RAW SIG =
.000907
.002140
.002140
.001520
.000907
.000292

NET SIG=
.00061[illegible]
.001[illegible]
.001[illegible]
.0012[illegible]
.00061[illegible]
.0000[illegible]

CORR SIG=
.000338
.001006
.000997
.000657
.000326
.000001

MICRO-WATTS CM-2
.010980
.027697
.025952
.015437
.009020
.000388

LOG MICRO-WATTS
-1.959384
-1.557560
-1.585829
-1.811432
-2.044779
-3.411686

Sta.47, Up/w

[illegible]	[illegible].0	[illegible].0
RD=	RD=	RD=
.000294	.000294	.000294
E00=	E00=	E00=
.002230	.002230	[illegible]02230
E01=	E01=	E01=
.002720	.002050	.001780
E02=	E02=	E02=
.002470	.001920	.001820
RAW SIG =	RAW SIG =	RAW SIG =
.000908	.000909	.000910
.001530	.001530	.001530
.001530	.001530	.001530
.000908	.000909	.001530
.000908	.000295	.000911
.000293	.000294	.000296
NET SIG=	NET SIG=	NET SIG=
.000614	.00061[illegible]	.00[illegible]
.001236	.001236	.00[illegible]
.001236	.00123[illegible]	[illegible]
.000614	.00061[illegible]	[illegible]
.000614	.00000[illegible]	.000[illegible]
.000001	0.00000[illegible]	.0000[illegible]
CORR SIG=	CORR SIG=	CORR SIG=
.000497	.000663	.000774
.000987	.001320	.001558
.000973	.001308	.001563
.000477	.000645	.001568
.000470	.000001	.000785
-.000001	0.000000	.000003
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.016140	.021539	.025154
.027174	.036357	.042919
.025337	.034046	.040695
.011208	.015151	.036857
.012999	.000029	.021709
-.000574	0.000000	.001755
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-1.792092	-1.666780	-1.599391
-1.565851	-1.439416	-1.367350
-1.596242	-1.467935	-1.390456
-1.950482	-1.819552	-1.433482
-1.886079	-4.542063	-1.663369
[illegible]00000	0.000000	-[illegible].755727

Sta. 47, Up/w

	.0	12.0	[illegible]
RD=	.000294	.000294	.000294
E00=	.002230	.002230	.002230
E01=	.001770	.001720	.001450
E02=	.001700	.001640	.001400
RAW SIG =	0.000000	.000911	.000912
	.001530	.002140	.002140
	.001530	.002140	.002140
	.000911	.001530	.001530
	.000911	.000911	.001530
	.000296	.000296	.000296
NET SIG=	-.000294	.000617	.00061[illegible]
	.001236	.001846	.00184[illegible]
	.001236	.001846	.00184[illegible]
	.000617	.001236	.0017[illegible]
	.000617	.000617	.0012[illegible]
	.000002	.000002	.000002
CORR SIG=	-.000368	.000795	.000946
	.001540	.002362	.002811
	.001531	.002346	.002797
	.000760	.001560	.001863
	.000755	.000773	.001854
	.000003	.000003	.000003
MICRO-WATTS CM-2	-.011966	.025817	.030728
	.042401	.065036	.077416
	.039847	.061056	.072807
	.017854	.036657	.043790
	.020878	.021375	.051245
	.001765	.001816	.002154
LOG MICRO-WATTS	0.000000	-1.588087	-1.512472
	-1.372626	-1.186844	-1.111172
	-1.399607	-1.214271	-1.137830
	-1.748253	-1.435848	-1.358628
	-1.680303	-1.670089	-1.290348
	[illegible]753203	[illegible]740872	[illegible]6706

Best Available Copy

Sta. 47, Up/W

RD=	RD=
.000297	.000297
E00=	E00=
.002230	.002230
E01=	E01=
.001580	.002350
E02=	E02=
.001780	.002570
RAW SIG =	RAW SIG =
.001530	.002140
.002740	.005180
.002740	.005180
.002740	.005180
.002140	.003970
.000297	.000295
NET SIG=	NET SIG=
[illegible]	.00184
[illegible]	.00488
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	.00367
[illegible]	-.000002
CORR SIG=	CORR SIG=
.001772	.001772
.003573	.004758
.003635	.004820
.003698	.004882
.002837	.003719
0.000000	-.000002
MICRO-WATTS CM-2	MICRO-WATTS CM-2
.057564	.057582
.098397	.131028
.094626	.125458
.086896	.114722
.078404	.102786
0.000000	-.001330
LOG MICRO-WATTS	LOG MICRO-WATTS
-1.239848	-1.239713
-1.007020	-.882637
-1.023989	-.901501
-1.061002	-.940354
-1.105661	-.968066
0.000000	0.000000

Best Available Copy

HUARSCI 83-01

DEPTH= 0.0

RD= .000304

E00= .005000

E01= .005100

E02= .004730

RAW SIG =
.659500
1.019000
1.206000
1.358000
1.472000
.042100

NET SIG=
.659196
1.018696
1.205696
1.357696
1.471696
.041096

CORR SIG=
.639566
.977999
1.145265
1.275538
1.367995
.037205

MICRO-WATTS CM-2
760.443793
792.179251
849.786765
771.881704
839.730619
749.689924

LOG MICRO-WATTS
2.881067
2.[illegible]323
2.[illegible]210
2.[illegible]7551
2.954113
[illegible]4882

DEPTH 1.0

RD= .000304

E00= .005000

E01= .004980

E02= .005190

RAW SIG =
.428000
.678400
.873100
1.106000
1.101000
.022500

NET SIG=
.427696
.678096
.872796
1.105696
1.100696
.022196

CORR SIG=
.432003
.689030
.892154
1.136914
1.138436
.024375

MICRO-WATTS CM-2
513.651651
558.114299
661.978127
687.832713
748.749616
491.156869

LOG MICRO-WATTS
2.710669
2.746723
2.820844
2.837483
2.[illegible]4337
[illegible]220

DEPTH 24.0

RD= .000290

E00= .005000

E01= .008440

E02= .003910

RAW SIG =
.270100
.567900
.594700
.480000
.365800
.000289

NET SIG=
.269810
.567610
.59441
.47971
.36551
-.00000

CORR SIG=
.161113
.341617
.360551
.293241
.225156
-.000001

MICRO-WATTS CM-2
191.563234
276.710042
267.528954
177.410602
148.085080
-.012256

LOG MICRO-WATTS
2.282312
2.442025
2.427371
2.248980
2.[illegible]0511
[illegible]00

Sta. 51, Dn/W

DEPTH	21.0	18.0	[illegible]5.5
RD=	.000290	.000290	.000289
E00=	.005000	.005000	.0[illegible]5000
E01=	.008190	.006870	.008560
E02=	.005730	.007390	.008760
RAW SIG =	.41[illegible]700	.348100	.549600
	.846200	.626900	.905300
	.854100	.655800	1.008500
	.486700	.572700	.849300
	.283500	.498900	.749700
	.000289	.000288	.000289
NET SIG=	.415610	.347[illegible]	.54931[illegible]
	.845910	[illegible]	.90501
	.853013	.65[illegible]	1.00821
	.486410	.572410	.84901
	.283212	.498610	.74941
	-.000001	-.000002	0.000000
CORR SIG=	.242932	.255377	.321931
	.472065	.473356	.549801
	.454085	.492573	.594811
	.245934	.434638	.502545
	.135768	.382529	.445053
	-.000001	-.000002	0.000000
MICRO-WATTS CM-2	288.727063	304.237453	382.776267
	382.372567	383.418375	445.338649
	336.930732	365.489256	441.349864
	148.790158	262.956060	304.039921
	89.294331	251.589136	292.711216
	-.010504	-.030601	0.000000
LOG MICRO-WATTS	2.460487	2.483213	2.582945
	2.582487	2.583673	2.648690
	2.527541	2.562875	2.644783
	2.172574	2.419883	2.482931
	1.950824	2.400692	2.4664[illegible]9
	[illegible]00000	[illegible]00000	[illegible]

Sta. 51, Dn/W

1.0

RD=
.000292
E00=
.005000
E01=
.011400
E02=
.011060

RAW SIG =
1.008000
1.605000
1.680000
1.541000
1.9700[illegible]
.0564[illegible]

NET SIG=
[illegible]

CORR SIG=
.440092
.697816
.727288
.664221
.845485
.023478

MICRO-WATTS CM-2
523.269625
565.230833
539.647676
401.853753
556.075208
473.081211

LOG MICRO-WATTS
2.718726
2.752226
2.732110
2.604068
2.745134
2.674936

[illegible]

RD=
.000292
E00=
.005000
E01=
.009050
E02=
.009570

RAW SIG =
.828500
1.406000
1.514000
1.777000
1.952000
.019800

NET SIG=
.828208
1.405708
1.513708
1.776708
1.951708
.019508

CORR SIG=
.461333
.789397
.856917
1.013868
1.122591
.011878

MICRO-WATTS CM-2
548.525136
639.411409
635.832707
613.390386
738.328123
239.345429

LOG MICRO-WATTS
2.739197
2.805780
2.803343
2.787737
2.868249
2.379025

Sta. 51, Dn/W

DEPTH
[illegible]2.0

RD=
.000269

.005000

.008570

E02=
.010440

RAW SIG
.530600
.843200
.938300
1.008500
.967000
.000191

NET SIG=
.530311
.842511
.938011
1.008211
.966711
.000002

CORR SIG
.319054
.522842
.598493
.661638
.652003
.000001

MICRO-WATTS CM-2
379.555037
423.502028
444.[illegible]1964
406.[illegible].144
428.822158
.028685

LOG MICRO-WATTS
2.579046
2.626855
2.647463
2.602376
2.[illegible]32277
[illegible]2348

[illegible].0

RD=
.000289

E00=
.005000

E01=
.008240

E02=
.009260

RAW SIG =
.582500
.896900
1.017000
1.063400
1.141500
.000905

NET SIG=
.582211
.896611
1.016711
1.063111
1.141211
.000617

CORR SIG=
.359537
.563321
.649698
.690768
.753772
.000424

MICRO-WATTS CM-2
427.489498
456.290321
482.076138
417.914562
495.755935
8.536807

LOG MICRO-WATTS
2.630925
2.659241
2.683116
2.621088
2.695268
[illegible]1295

[illegible]
[illegible] 0

RD=
.000292

EA0=
.005000

E01=
.009210

E02=
.009460

RAW SIG =
.714400
1.201000
1.292000
1.428000
1.488000
.003960

NET SIG=
.714108
1.200708
1.291708
1.427708
[illegible]
.003668

CORR SIG=
.389166
.656711
.709419
.787120
.823334
.002068

MICRO-WATTS CM-2
462.741706
532.097644
526.388930
476.207736
541.506980
41.679988

LOG MICRO-WATTS
2.665339
2.725991
2.721307
2.677796
2.733604
[illegible]9918

NUA [illegible]-0[illegible]

STA NO [illegible]
[illegible]1

[illegible]

DEPTH-	DEP[illegible]	DEPT
1.0	24.0	21.0
RD=	RD=	RD=
.000290	.000290	.000290
E00=	E00=	E00=
.005000	.005000	.005000
E01=	E01=	E01=
.010360	.009450	.005210
E02=	E02=	E02=
.010450	.009419	.005990
RAW SIG =	RAW SIG =	RAW SIG =
.011280	.003350	.002130
.026540	.013720	.009460
.030190	.014930	.010050
.021159	.009460	.007320
.016160	.006400	.004590
.000254	.000290	.000289
NET SIG=	NET SIG=	NET SIG=
.01[illegible]	.003060	.001[illegible]
.026[illegible]5[illegible]	.013430	.009[illegible]
.029[illegible]	.014643	.0097[illegible]
.021560	.009170	.0067[illegible]
.0152[illegible]	.006110	.0043[illegible]
.000[illegible]	0.000000	-.000001
CORR SIG=	CORR SIG=	CORR SIG=
.005211	.001618	.001904
.012700	.007097	.009177
.014479	.007732	.009968
.010651	.004840	.007012
.007707	.003223	.004558
.000002	0.000000	-.000001
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.172543	.052571	.058600
.349769	.195457	.252740
.376900	.201263	.259472
.250301	.113742	.164778
.213017	.089084	.125977
.001352	0.000000	-.000673
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-.[illegible]63103	-1.279254	-1.232101
-.456219	-.708948	-.597326
-.423774	-.696236	-.5[illegible]10
-.601537	-.944077	[illegible]31
-.[illegible]556	-1.050199	[illegible]97
[illegible]00301	[illegible]00000	[illegible]00

Sta. 51, Up/W

DEPT 18.0	DEPT 15.5	DEPT 12.0
RD=	RD=	RD=
.000289	.000289	.000289
E00=	E00=	E00=
.005000	.005000	.005000
E01=	E01=	E01=
.007570	.007600	.008020
E02=	E02=	E02=
.009150	.007970	.008960
RAW SIG =	RAW SIG =	RAW SIG =
.003340	.003960	.005790
.011900	.011890	.017370
.014930	.011890	.018000
.010660	.010050	.012500
.007610	.008220	.008840
.000289	.000288	.000290
NET SIG=	NET SIG=	NET SIG=
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
0.000000	-.000000	.000001
CORR SIG=	CORR SIG=	CORR SIG=
.002375	.002432	.003126
.008127	.007739	.009727
.010536	.007792	.010109
.007668	.006601	.006985
.005557	.005399	.004903
0.000000	-.000001	.000001
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.067428	.079014	.101549
.223914	.213118	.267883
.274260	.202816	.263127
.180195	.155113	.164152
.153600	.149239	.135506
0.000000	-.000461	.000397
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-1.171161	-1.102296	-.993323
-.650112	-.671379	-.572054
-.561838	-.692897	-.579834
-.744257	-.809353	-.784754
-.813609	-.826117	[illegible]868042
[illegible]000000	[illegible]00000	[illegible]1068

Sta. 51, Up/W

9.0	6.0	[illegible].0
RD=	RD=	RD=
.000292	.000292	.000292
E00=	E00=	E00=
.005000	.005000	.005000
E01=	E01=	E01=
.007630	.009260	.009760
E02=	E02=	E02=
.008290	.008800	.010540
RAW SIG =	RAW SIG =	RAW SIG =
.005170	.007610	.009460
.014930	.022250	.024700
.016160	.022900	.026530
.012500	.018000	.021660
.009460	.013720	.018080
.000293	.000293	.000292
NET SIG=	NET SIG=	NET SIG=
.00487	.007318	.00[illegible]
.01463	.021958	.0244[illegible]
.01586	.022608	.0262[illegible]
.01220	.017708	.0213[illegible]
.00916	.013428	.0177[illegible]
.00000	.000001	0.000000
CORR SIG=	CORR SIG=	CORR SIG=
.003236	.003923	.004750
.009836	.011688	.012790
.010784	.011947	.013902
.008396	.009290	.011447
.006379	.006993	.009590
.000001	.000001	0.000000
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.105142	.127469	.154340
.270710	.321885	.352234
.280715	.310985	.361881
.197302	.218312	.269008
.176328	.193227	.265070
.000459	.000378	0.000000
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-.[illegible]8224	-.894595	-.811520
-.5[illegible]496	-.492299	-.453169
-[illegible]1734	-.507260	-.441425
-[illegible]1869	-.660923	-.570236
[illegible]50	[illegible]	[illegible]
59		

Sta. 51, Up/w

```
RD=
          .003299
EP0=
          .005000
EC1=
          .011500
EC2=
          .0[illegible]750

CPM SIG =
          .[illegible]290
          [illegible]500
          [illegible]70
          [illegible]0
          .0[illegible]50
          [illegible]

    Q=
          [illegible]
          [illegible]
          [illegible]
          [illegible]
          .03[illegible]56
          0.000000

CORR SIG=
          .005188
          .012687
          .013139
          .010653
          .008508
          0.000000

MICRO-WATTS CM-2
          .166560
          .349402
          .341984
          250346
          .235167
          0.000000

LOG MICRO-WATTS
          -[illegible]44
          [illegible]75
          [illegible]5
          [illegible]
          [illegible]
          [illegible]
```

[illegible] 9-01		
55		
[illegible]		
DEPT. 0.0	DEPT. 1.5	DEPT. 48.0
RD= .000315	RD= .000315	RD= .000302
E00= .003590	E00= .003590	E00= .003590
E01= .004060	E01= .003590	E01= .010500
E02= .010710	E02= .004910	E02= .006250
RAW SIG =	RAW SIG =	RAW SIG =
.583300	.599000	.005190
1.022000	8413.000000	.028400
1.944000	.909700	.024100
3.344000	1.078000	.019200
3.543000	1.137000	.010700
.107100	.026600	.000303
NET SIG=	NET SIG=	NET SIG=
.682985	.598685	.004876
1.021685	8412.999685	.028098
1.943685	.909385	.023798
3.343685	1.077685	.018[illegible]
3.542685	1.136685	.010398
.106785	.026285	.000001
CORR SIG=	CORR SIG=	CORR SIG=
.745373	.630163	.001571
1.326613	9297.700421	.008495
2.926344	1.052830	.006724
5.726644	1.304341	.004965
6.801190	1.435516	.002526
.611553	.036700	.000000
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
[illegible]6.248414	749.264390	1.868243
1074.556127	7.531137341E 06	6.880734
2171.347351	781.199651	4.989044
3464.619717	789.126346	3.004047
4473.142785	944.138876	1.661518
1.232279444E 04	739.514678	.006837
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
2.947555	2.874635	.271435
3.031229	6.876861	.837635
3.336729	2.892762	.698017
[illegible]39656	2.897147	.477707
[illegible]50613	2.975036	.220505
[illegible]	[illegible]8947	[illegible]5155

Best Available Copy

Sta. 55, Dn/W

DEPTH=	24.0	21.0	18.0
RD=	.000302	.000302	.000300
E00=	.003590	.003590	.003590
E01=	.009950	.009460	.007390
E02=	.003280	.008270	.009630
RAW SIG =	.069200	.068200	.106500
	.196200	.264000	.313400
	.227900	.302400	.374400
	.151000	.278000	.342600
	.115600	.255400	.328600
	.000301	.000303	.000302
NET SIG=	.069493	.067898	.106299
	.195098	.263691	.313129
	.227599	.302098	.374100
	.150698	.277698	.342300
	.115298	.255091	.328300
	-.000001	.000001	.000002
CORR SIG=	.022671	.032757	.053228
	.057130	.096471	.161755
	.058503	.108457	.199037
	.033524	.097802	.187395
	.021661	.088101	.184792
	-.000000	.000000	.000001
MICRO-WATTS CM-2	26.956349	38.947608	63.288449
	46.275157	78.141668	131.021678
	43.408949	80.475228	147.685132
	20.281904	59.169947	113.373808
	14.246471	57.943850	121.537403
	-.006536	.007380	.021065
LOG MICRO-WATTS	1.430661	1.590481	1.801324
	1.665348	1.892883	2.117343
	[illegible].637579	1.905662	2.169327
	1.307109	1.772101	2.054513
	[illegible]53707	1.763007	2.084710
	[illegible]00000	[illegible]21964	-1.676447

Sta. 55, Dn/W

[illegible]	DEPTH=	DEPTH=
15.0	12.0	9.0
[illegible]	RZ=	RZ=
.000300	.000300	.000300
[illegible]	E00=	E00=
.003590	.003590	.003590
E01=	E01=	E01=
.005620	.005730	.009750
E02=	E02=	E02=
.009980	.003860	.009450
RAW SIG =	RAW SIG =	RAW SIG =
.115000	.116200	.282900
.201100	.199900	.586800
.202300	.229200	.657600
.183400	.243800	.752200
.286500	.258500	.743600
.000300	.000299	.000916
NET SIG=	NET SIG=	NET SIG=
.114700	.115900	.282600
.200800	.199600	.586500
.202000	.228900	.657300
.183100	.243500	.751900
.286200	.258200	.743300
0.000000	-.000001	.000616
CORR SIG=	CORR SIG=	CORR SIG=
.081393	.069226	.103597
.156729	.113383	.214052
.171981	.123334	.238827
.168865	.124081	.271981
.284232	.124022	.267666
0.000000	-.000001	.000222
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
96.781827	82.309336	123.176748
126.950689	91.939891	173.382061
127.609916	91.513535	177.209301
102.163616	75.068720	164.548393
186.939685	81.569076	176.043771
0.000000	-.011621	4.464573
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
1.985794	1.915449	2.090529
2.103635	1.963031	2.239004
2.105884	1.961485	2.248487
2.009296	1.875459	2.216294
2.271702	1.911526	2.245621
[illegible]	[illegible]	.649790

Sta.55, Dn/W

DEPTH=	6.0	3.0	1.0
RD=	.000300	.000300	003010
E00=	.003590	.003590	.003590
E01=	.008330	.009580	.003610
E02=	.011370	.008810	.007910
RAW SIG =	.392700	.605700	.570300
	.621500	1.135000	1.049000
	.586800	1.237000	1.172000
	.605700	1.442000	1.517000
	.65820	1.674200	1.657000
	.06215	.014350	.029570
NET SIG=	.392400	.605400	.567290
	.621200	1.134700	1.045990
	.586500	1.236700	1.168990
	.605400	1.441700	1.513990
	.657900	1.673700	1.653990
	.061850	.014050	.026560
CORR SIG=	.177939	.224259	.233786
	.295663	.415442	.425993
	.292339	.447460	.470418
	.315376	.515423	.601912
	.357522	.591156	.649554
	.000973	.004655	.009711
MICRO-WATTS CM-2	211.569639	266.644504	277.971061
	239.487198	336.507808	345.053443
	216.915318	332.015176	349.050442
	190.802211	31[illegible].830788	364.156884
	235.142076	388.803518	427.211510
	19.615074	93.797794	195.681661 216
LOG MICRO-WATTS	2.325453	2.425933	2.444009
	2.379282	2.526995	2.537886
	2.336290	2.521158	2.542888
	2.280583	2.493919	2.561289
	2.371330	2.589730	2.630643
	[illegible]90	[illegible]	[illegible]

[illegible]

DEPTH=

	1.5	24.0	[illegible]
RD=	.000304	.000304	.000303
E00=	.003590	.003590	.003590
E01=	.009890	.010490	.009630
E02=	.009900	.009640	.008390
RAW SIG =	.007030	.000303	.000918
	.019230	.003360	.003360
	.021670	.003360	.003970
	.022880	.002740	.002740
	.022880	.001540	.002740
	.0003[illegible]	.000303	.000304
NET SIG=	.000726	-.000001	.00061[illegible]
	.018926	.003056	.00305[illegible]
	.021[illegible]6	.003056	.00366[illegible]
	.02[illegible]6	.002436	.00243[illegible]
	.022576	.001236	.002437
	.000002	-.000001	.000001
CORR SIG=	.002442	-.000000	.000225
	.006872	.001022	.001098
	.007759	.001010	.001292
	.008200	.000795	.000842
	.008201	.000398	.000825
	.000001	-.000000	.000000
MICRO-WATTS CM-2	.079335	-.000011	.007312
	.189255	.028135	.030230
	.201[illegible]9	.026277	.033613
	.192692	.018683	.019777
	.226672	.011014	.022799
	.000508	-.000240	.000261
LOG MICRO-WATTS	-1.100532	0.000000	-2.135978
	-.722953	-1.550747	-1.519568
	-.694716	-1.580419	-1.473425
	-.715136	-1.728546	-1.703835
	[illegible]44603	[illegible]58044	[illegible]42084
	[illegible]93716	[illegible]00000	[illegible]83322

Sta. 55, Up/W

DEPTH=	DEPTH=	DEPTH=
18.0	15.0	[illegible].0
RD=	RD=	RD=
.000303	.000300	.000300
E00=	E00=	E00=
.003590	.003590	.003590
E01=	E01=	E01=
.009220	.010500	.002990
E02=	E02=	E02=
.009155	.009820	.003940
RAW SIG =	RAW SIG =	RAW SIG =
.000917	.001530	.000914
.004590	.005800	.002150
.005180	.007030	.002740
.004590	.006410	.002740
.003970	.005180	.002740
.000301	.000303	.000299
NET SIG=	NET SIG=	NET SIG=
.000614	.001[illegible]30	.000614
.004287	.00[illegible]500	.00155[illegible]
.004877	.006730	.002440
.004287	.006110	.0024[illegible]
.003667	.004880	.0024[illegible]
-.000002	.000003	-.0000[illegible]
CORR SIG=	CORR SIG=	CORR SIG=
.000239	.000417	.000771
.001666	.001846	.002423
.001893	.002237	.003329
.001663	.002012	.003462
.001421	.001591	.003595
-.000001	.000001	-.000001
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.007760	.013537	.025040
.045878	.050829	.066732
.049280	.058231	.086653
.039069	.047274	.081358
.039266	.043982	.099370
-.000545	.000718	-.000842
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-2.110156	-1.868481	-1.601362
-1.338396	-1.293888	-1.175668
-1.307325	-1.234[illegible]42	-1.062218
-1.408170	-1.325379	-1.089597
-1.405982	-1.356727	-1.002743
[illegible]00000	[illegible]3799	[illegible]1000

Sta. 55, Up/W

DEPTH=	[illegible]	
9.0	6.0	3.0
RD=	RD=	RD=
.000300	.000301	.000301
E00=	E00=	E00=
.003590	.003590	.003590
E01=	E01=	E01=
.006440	.005990	.006970
E02=	E02=	E02=
.004210	.004480	.006200
RAW SIG =	RAW SIG =	RAW SIG =
.001530	.002150	.003360
.006410	.006410	.008240
.004590	.014350	.008240
.003360	.006420	.007030
.003360	.005180	.005800
.000300	.000301	.000301
NET SIG=	NET SIG=	NET SIG=
.001230	.001849	.003059
.006110	.006109	.007939
.004290	.014049	.007939
.003060	.006119	.006729
.003060	.004879	.005499
0.000000	0.000000	0.000000
CORR SIG=	CORR SIG=	CORR SIG=
.000652	.001068	.001551
.003069	.003397	.003960
.002036	.007509	.003895
.001368	.003139	.003247
.001283	.002397	.002609
0.000000	0.000000	0.000000
MICRO-WATTS CM-2	MICRO-WATTS CM-2	MICRO-WATTS CM-2
.021174	.034706	.050382
.084513	.093563	.109056
.053003	.195471	.101395
.032147	.073755	.076301
.035475	.066256	.072102
0.000000	0.000000	0.000000
LOG MICRO-WATTS	LOG MICRO-WATTS	LOG MICRO-WATTS
-1.674192	-1.459591	-1.297725
-1.073078	-1.028896	-.962352
-1.275701	-.708?19	-.993985
-1.492865	-1.132209	-1.117469
-1.450075	-1.178779	[illegible]
0	0	

Sta. 55, Up/W

..0

RD=
.000301
E00=
.003590
E01=
.008425
E02=
.006260

RAW SIG =
.004590
.011900
.013730
.014340
.016170
.000299

NET SIG=
.004289
.011599
.013429
.014039
.015869
-.000002

CORR SIG=
.001760
.004579
.005091
.005103
.005520
-.000001

MICRO-WATTS CM-2
.057197
.126112
.132530
.119918
.152561
-.000595

LOG MICRO-WATTS
-1.242629
-.899243
-.877685
-.921117
-.816557
0.000000

APPENDIX D

LOG SHEETS

(a) Daily Log
(b) Data Prirtout Supplement

[redacted] OCEANOGRAPHIC RESEARCH [redacted] LOG
1IND NUC-3161 2 (REV. 6 73)

Flyover Time = 11:43 EST

DATE	TIME ABOARD	TIME SECURED	
15 Feb. 80 Friday	All Day	0630 – 1630	[redacted] (9½ hrs)

AIR TEMP	AT TIME		AT TIME
21.5°C	1107 EST		

BT TIME	SURFACE					
1107 EST	20.1 °C, Bkt.					

SWELL HEIGHT DATA, METEOROLOGICAL DATA

TIME	MAXIMUM HEIGHT (Meters)	AVERAGE HEIGHT (Meters)	PERIOD (Sec)	DIRECTION (Deg)
1107 EST		0.7		

VISIBILITY (mi)	WEATHER	WIND SPEED (Kts)	WIND DIRECTION (Deg)
4	100% overcast	4	090°

SEA STATUS	STICKS	SECCHI (Meters)
	☐ MANY ☐ FEW ☐ NONE	22

~~PSYCHROM. TEMP~~ ~~WET~~ ~~DRY~~		~~RELATIVE HUMIDITY (Percent)~~	PRESSURE (mb)
			1017.3 @ 1107EST

[redacted]

Time	Water Temp.	Sta.	EQUIPMENT CHECKED	Lat. Long.		Sea State	Time
GMT 0157	~~ARRAY BOUYS~~ 17.5 °C	44		[redacted] 26°14'N; 82°36'W		[redacted] 0–1	0900
0715	~~ANEMOMETER~~ 20.2	45		[redacted] 26°05'N; 83°20'W		[redacted] 0–1	1000
1403	~~TIDE GAUGE~~ 20.2	46		[redacted] 26°44'N; 84°13'W		[redacted] 0–1	1500
1607	~~WAVE HEIGHT~~ 20.1	47		[redacted] 26°46'N; 84°07'W		OTHER	
	~~CABLES~~			[redacted]		OTHER	

~~PERSONNEL ABOARD~~

a) Computed Satellite Flyover time + discussed scheduling @ Marak + Bill Brennan, later @ Cdr. Fleming.

b) Started Deck Cell monitoring, 100% overcast + not encouraging.

c) Took H(λ) data from ≈1100hrs → 1230 hrs. EST; Hydrocast taken after H(λ) this station (#47).

STUDIES IN PROGRESS

d) Determined relation between Secchi reading/depth + $Z_u(.01)$.

e) Terminated Deck Cell @ 1520 hrs.

EQUIPMENT CHANGES REMARKS

(a) Daily log.

DATA SHEET
1:NP NOSC 5220 1 (4-77)

TITLE
NOAACZCS Water Irradiance Measurements

DATE
2/15/80 Friday

Station: ~~#~~ 47

Lat. 26°46'N, Long. 84°07'W
@ 1107 hrs. EST

Data Period = 10 Sec.
Flyover Time = 1143 hrs. EST
T_{air} = 21.5 °C, Secchi = 22 m
Wind: [illegible] 4kn @ 090°
$Z_u \approx 88$ m $Z_{bot.} = 121$ m

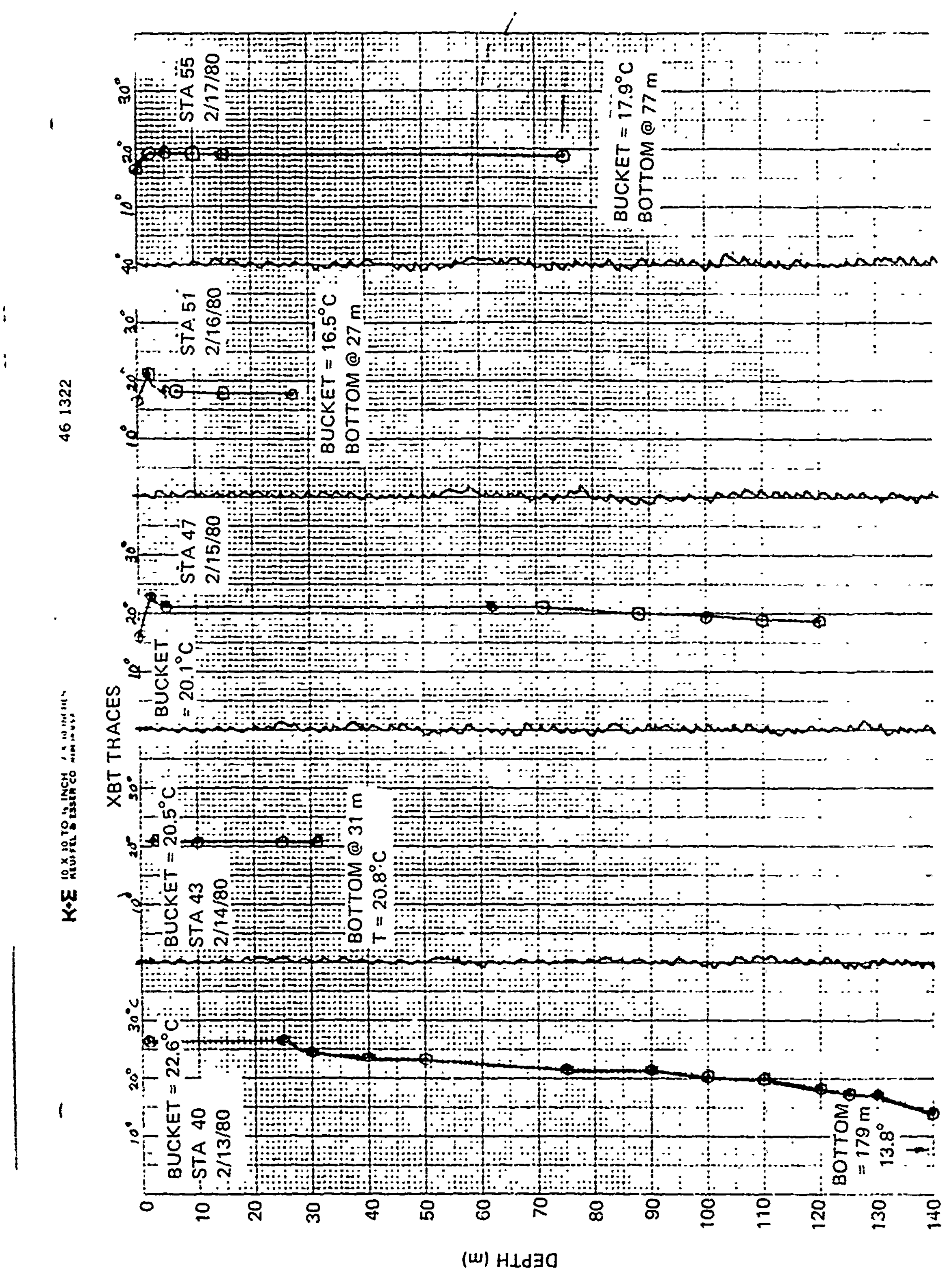
Time (hrs.)	T (°C)	Depth (m)	P (°)	R (°)	H.V. (kV)	Filter Set DN/W	Up/W	TEST	Bkg.	Comments		
t_o 1054	24	—	✓	✓	1.05	—	—	430,078	363	Turn On		
1111	29	—	—	—	1.06	—	—	421,377	606			
1115	30	—	—	—	1.05	—	—					
1116		Air ✓						Air Reference ✓				
					.19	.131	.135	.142	.147	.012		Removed rope
1118		+ ~~[illegible]~~ 1			F1 .34	F2 .55	F3 .615	F4 .73	F5 .811	F6 .016		
1125	27											1.05 kv
1130		26				.123	.131	.103				
1136		52				.63	.029	.017				
1138		72				.014	.014	.005				
		93				.003	.0027	TEST	~~Bkg.~~	← Record/Printer		
1143	29	90	✓	✓	1.05							
		44				✓	✓					
1158		40				✓	✓					
1200	29	36	-1/3	0/1	1.05	✓	✓					
1204		32				✓	✓					
1213		28.5				✓	✓					
1218	29	24			1.05	✓	✓					
	29	20			1.05	✓	✓					
1230		16				✓	✓					
1235		12				✓	✓					
1238		8				✓	✓					
1244	28	4			1.05	✓	✓					
1248		1				✓	✓					
1254						Off + Out						

OBSERVERS   SHEET   OF   SHEETS

(b) Data printout supplement.

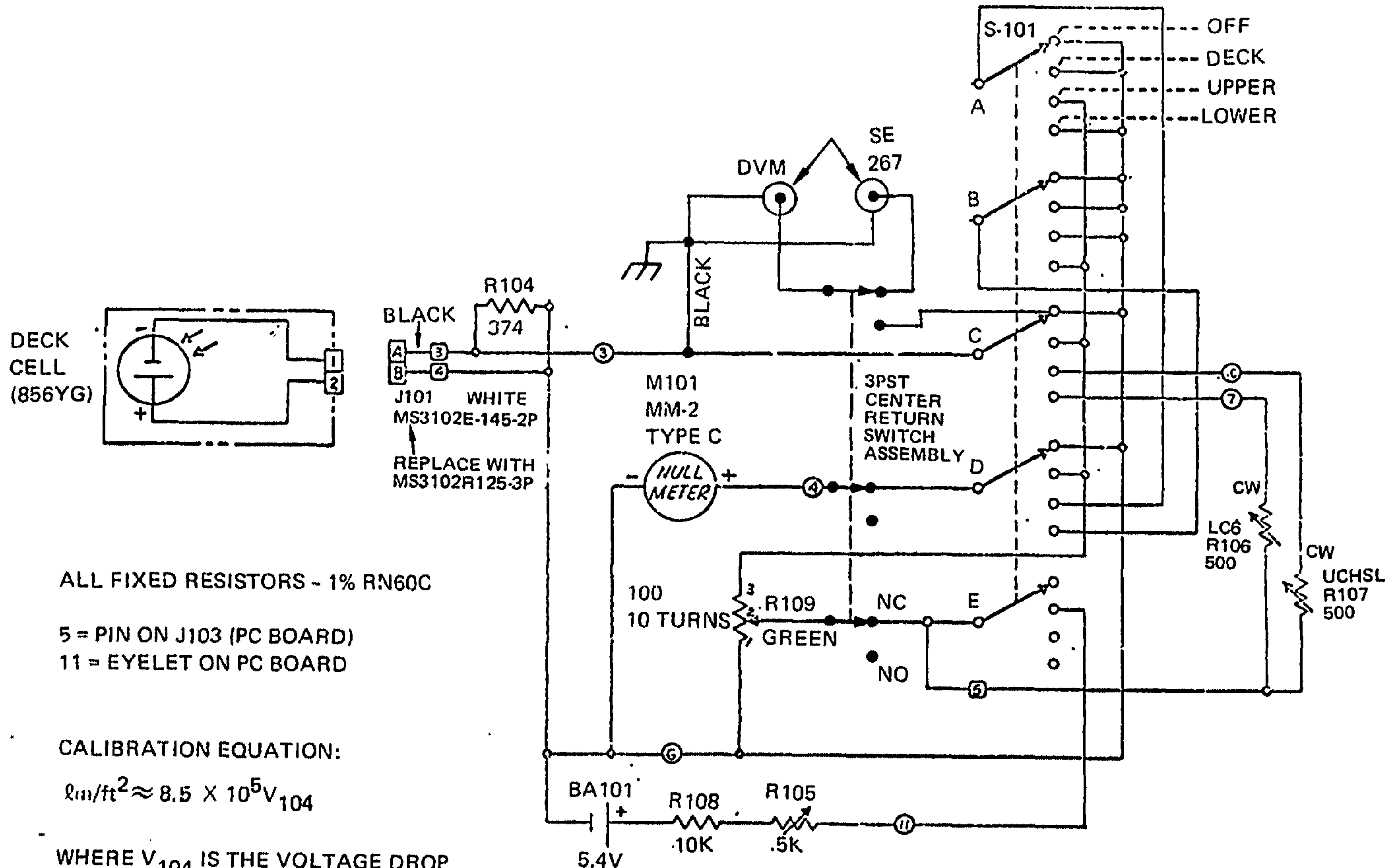
APPENDIX E

XBT TRACE COPIES


XBT TRACES
BUCKET = 22.6°C
STA 40
2/13/80
BOTTOM = 179 m
13.8°
BUCKET = 20.5°C
STA 43
2/14/80
BOTTOM @ 31 m
T = 20.8°C
BUCKET = 20.1°C
STA 47
2/15/80
STA 51
2/16/80
BUCKET = 16.5°C
BOTTOM @ 27 m
STA 55
2/17/80
BUCKET = 17.9°C
BOTTOM @ 77 m
DEPTH (m)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
10°
20°
30°C
46 1322

APPENDIX F

EQUIPMENT ITEMS



ALL FIXED RESISTORS - 1% RN60C

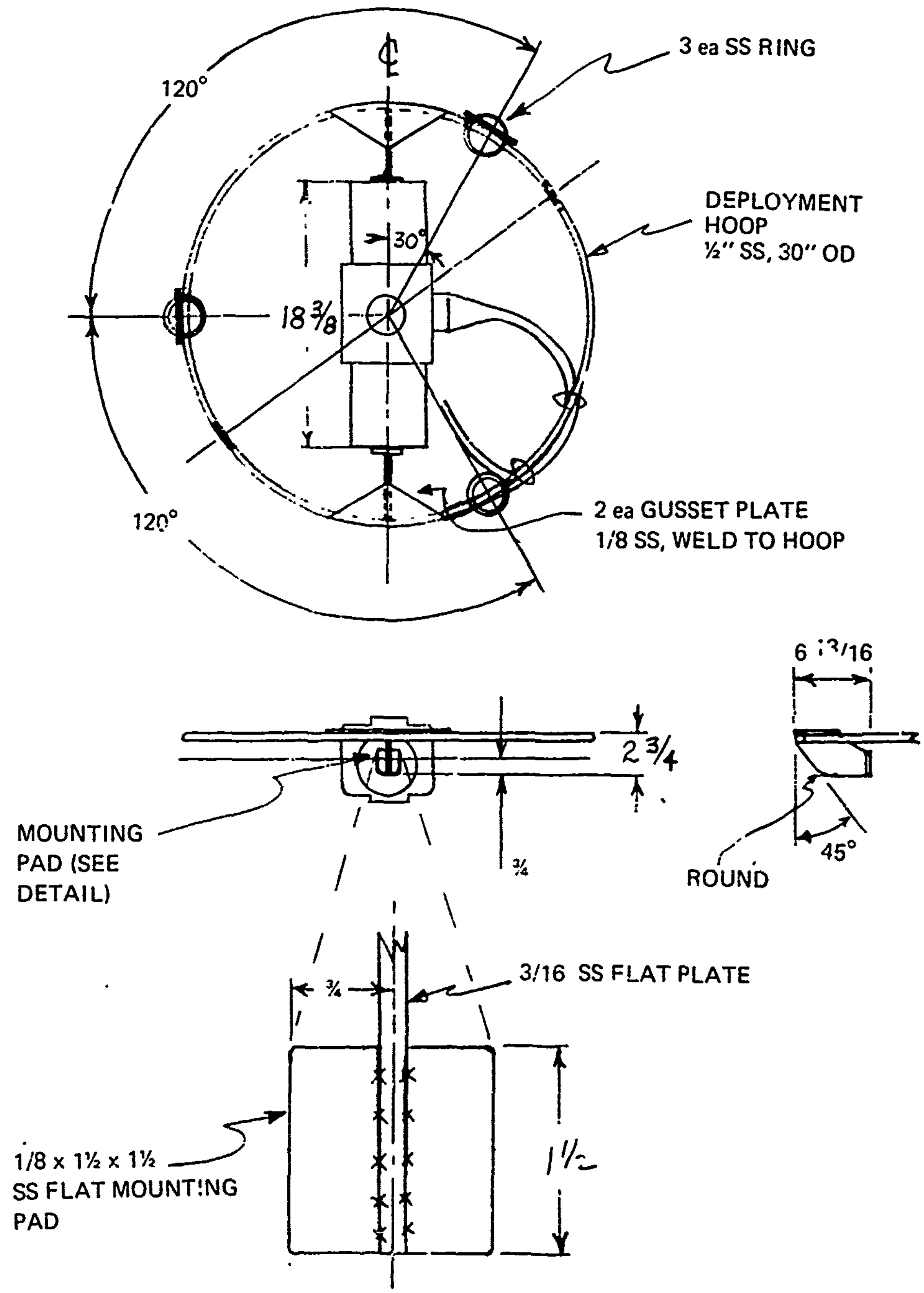
5 = PIN ON J103 (PC BOARD)
11 = EYELET ON PC BOARD

CALIBRATION EQUATION:

$\ell m/ft^2 \approx 8.5 \times 10^5 V_{104}$

WHERE V_{104} IS THE VOLTAGE DROP ACROSS R104.

Deck Cell Meter Readout Schematic.



Underwater unit deployment hoop.